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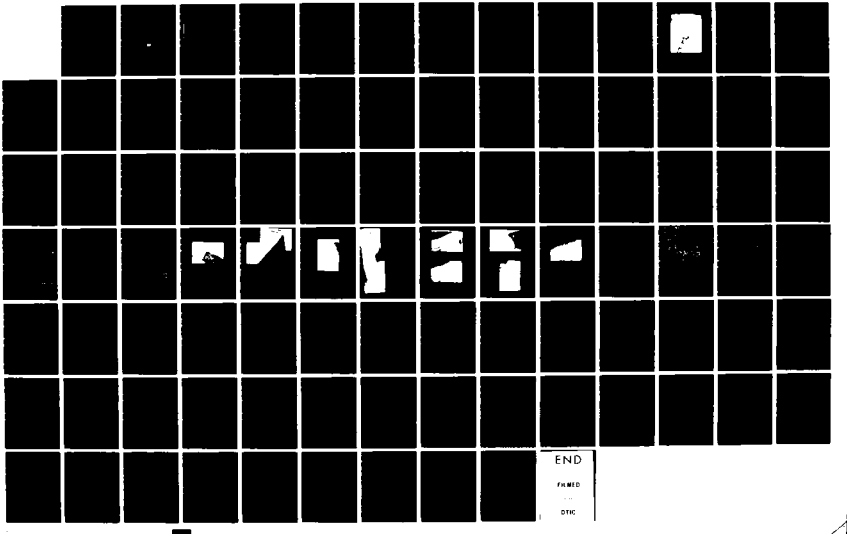

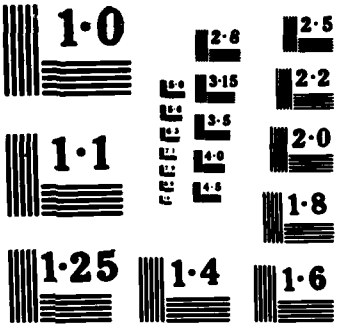
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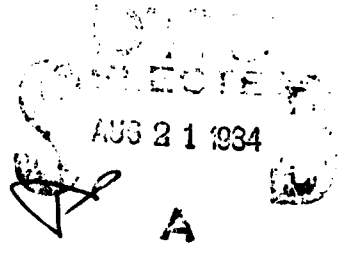
HOUSATONIC RIVER BASIN

LITCHFIELD & WARREN, CONNECTICUT

SHEPAUG RESERVOIR DAM
CT 00665

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

MAY 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Housatonic River Basin
Litchfield & Warren, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Shepaug Reservoir Dam is a 500 foot long gravity concrete and earth embankment dam. The concrete gravity section is 390 feet long and has a maximum height of 65 ft. The visual inspection indicated that the dam was in good condition. Based on its intermediate size and high hazard classification the test flood is equal to ½ the PMF.

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SHEPAUG RESERVOIR DAM

CT 00665

HOUSATONIC RIVER BASIN
LITCHFIELD AND WARREN, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.: 00665

Name of Dam: Shepaug Reservoir Dam

Town: Litchfield and Warren

County and State: Litchfield, Connecticut

Stream: Shepaug River

Date of Inspection: December 6, 1978

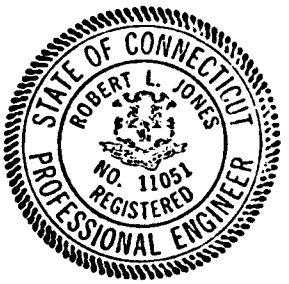
Shepaug Reservoir Dam is a 500 foot long gravity concrete and earth embankment dam. The concrete gravity section is 390 feet long and has a maximum height of 65 feet. The earth embankment section is 110 feet long with a height of about 35 feet. The top width of the concrete section is 12 feet. The top width of the earthen section is variable and 18 feet minimum. Engineering data available consisted of a set of plans dated September 1933 showing plan, elevation and details of the dam. No construction specifications or design calculations were available.

The visual inspection of Shepaug Reservoir Dam indicated that the dam is in good condition. The inspection revealed that an erosion feature has developed on the intermediate berm of the downstream slope adjacent to the tunnel entrance. There is some minor sloughing of the downstream slope of the embankment about 60 feet east of the gatehouse. The inspection also revealed areas of wet concrete which indicate seepage near the downstream toe of the spillway in the center one-third of the spillway section and considerable spalling of concrete.

Based on its intermediate size and high hazard classification in accordance with the Corps guidelines the test flood is equal to 1/2 the Probable Maximum Flood. The spillway will discharge 18,725 cfs or 75 percent of the test flood with the pool level at the top of the dam. The test flood flow of 24,850 cfs will overtop the dam by 1.4 feet.

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is need for more detailed engineering studies to determine spillway adequacy. Also, the owner should repair the spillway section where apparent seepage and spalling occurs. The areas of sloughing and erosion should also be repaired.

The recommendations and remedial measures are described in Section 7 and should be addressed within one year after receipt of this Phase I - Inspection Report by the owner.



Robert L. Jones, P.E.
Project Manager

Philip W. Genovese & Associates, Inc.
Hamden, Connecticut

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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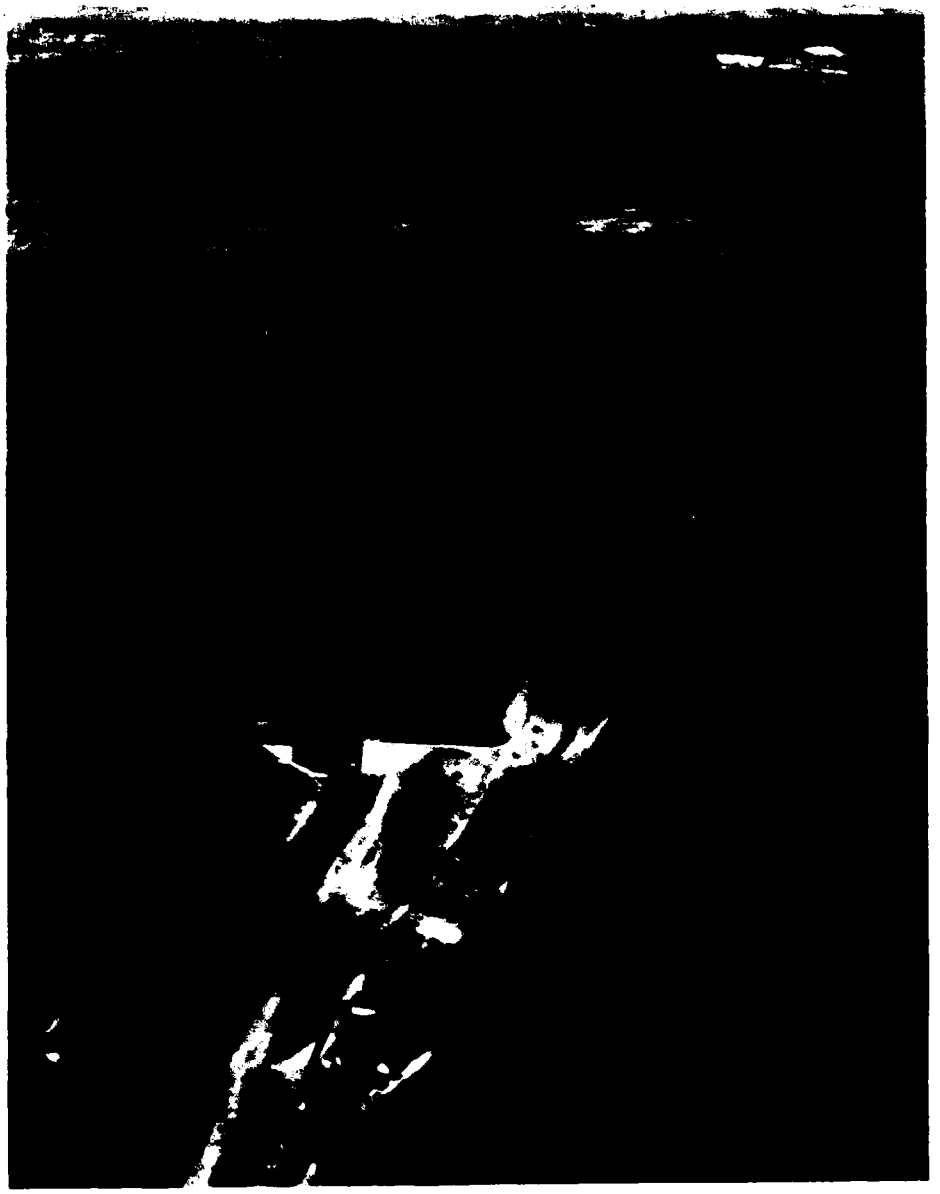

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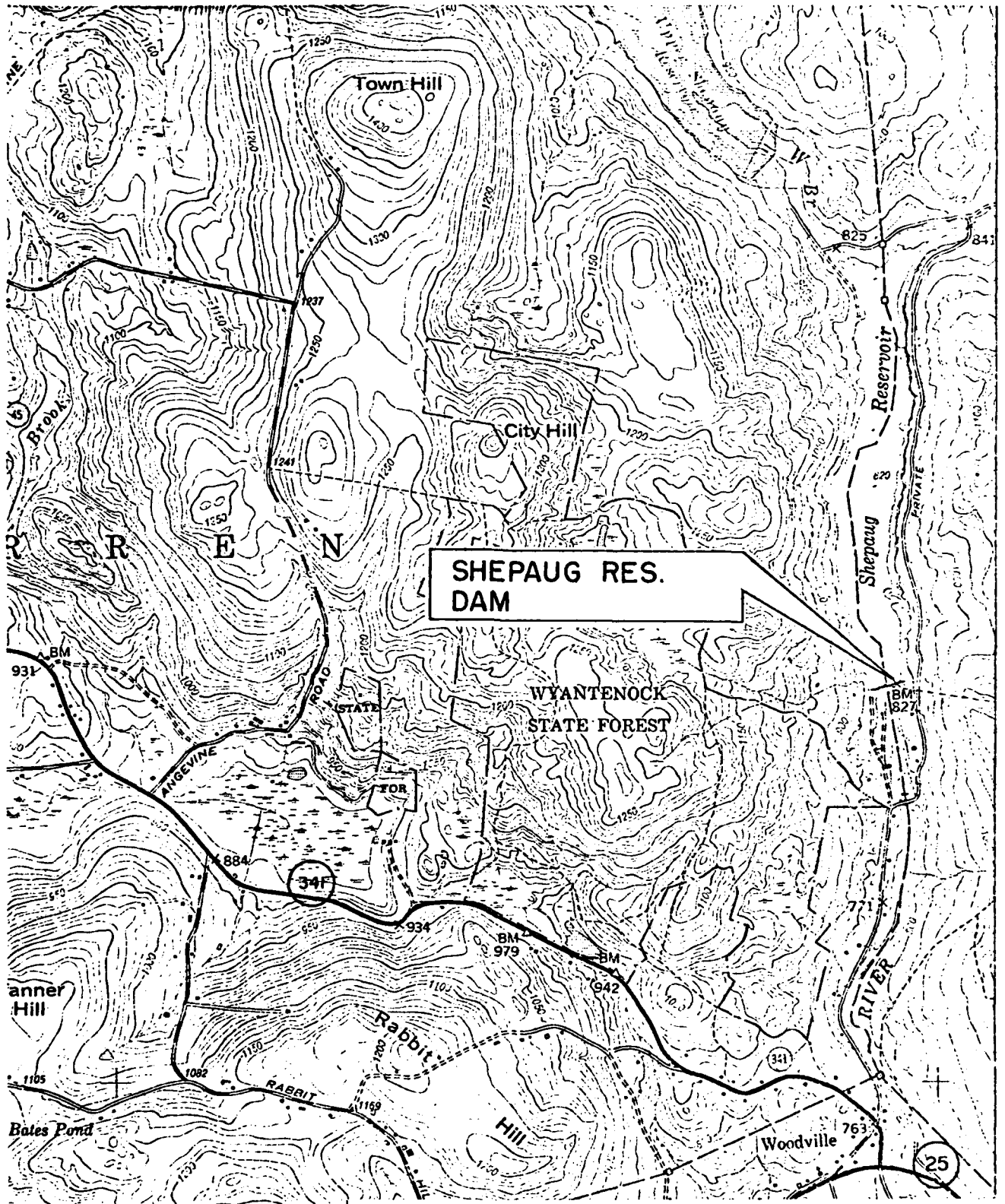
PHILIP W. GENOVESE AND ASSOCIATES, INC. ENGINEERS-HAMDEN, CT.		CE NO. _____ DATE _____ PAGE _____



PHILIP W. GENOVESE AND ASSOCIATES, INC.
ENGINEERS-HAMDEN, CT.

U.S. ARMY ENGINEER DIV.
NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
LOCATION MAP

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Philip W. Genovese and Associates, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Philip W. Genovese and Associates, Inc. under a letter of November 28, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C0019 has been assigned by the Corps of Engineers for this work.

b. Purpose.

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Shepaug Reservoir Dam is located on the Shepaug River in the Towns of Litchfield and Warren, Connecticut. The dam is approximately 1.1 miles upstream from the Shepaug River crossing of Route 25 in the Village of Woodville. The dam is shown on U.S.G.S. Quadrangle, New Preston, Connecticut with coordinates approximately N 41°- 43.4'- ; W- 73°- 17.6', Litchfield County, Connecticut. The location of the dam is shown on the Location Map immediately preceding this page.

b. Description of Dam and Appurtenances. Shepaug Reservoir Dam consists of concrete gravity section and an earth embankment section. The concrete section of the dam, consisting of 145.3 feet spillway and 73.3 feet spillway, has a total length of about 390 feet. The earth embankment section is about 110 feet long. The overall length of the dam is approximately 500 feet. The spillway is located on the right (west) side of the embankment.

The maximum structural height, according to existing plans, is 65 feet for the concrete section and about 35 feet for the earth embankment. The existing plans indicate that both sections of the dam are founded on bedrock.

The appurtenant structures consist of a concrete spillway, spillway channel and an outlet works structure. The spillway section consists of a 145.3 foot segment with a crest elevation of 820 feet and a 73.5 foot segment with a crest elevation of 819.0 feet.

The outlet works consist of an intake channel, a control tower containing two identical chambers and five gates in each chamber and a discharge channel. Of the five gates, three control intake and two control discharge from the gate chamber. Of the three intake gates and conduits, the lowest gate is located at elevation 769 feet and the highest gate is located at elevation 810 feet. The discharge gates and conduits are of elevations 769 feet and 793 feet respectively. Each chamber also has an 8 inch cast iron pipe outlet at elevation of 767 feet to supply the fountain downstream to maintain minimum flow.

Figure I, located in Appendix B, shows the plan of the dam and its appurtenant structures. Photographs of each structure are shown in Appendix C.

c. Size Classification. Intermediate (hydraulic height - 65 feet high, storage 2037 acre-feet) based on storage ($\geq$ 1,000 to 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The dam's potential for damage rates it as a high hazard classification. A major breach could result in a maximum flood wave stage of about 37 feet in Woodville, 1.1 miles downstream. Structures that could be affected by a dam breach from the dam to the Village of Woodville include about 12 houses three of which are close to the river and one is essentially at the grade of the river. A flood wave of the magnitude described could cause substantial damage and loss of life.

e. Ownership. This dam is owned by the City of Waterbury, 236 Grand Street, Waterbury, Connecticut.

f. Operator. This dam is owned and operated by the City of Waterbury, Connecticut Bureau of Water. The Superintendent of Reservoirs is Mr. Leonard J. Assard, telephone 203-283-9139.

g. Purpose of Dam. This dam is used for water supply for the City of Waterbury.

h. Design and Construction History. Shepaug Reservoir Dam was constructed in about 1933. Plans are signed by Robert A. Cairns, City Engineer of Waterbury. All drawings are on file with the owner.

i. Normal Operating Procedure. No data was disclosed for maintenance of reservoir water levels. Under normal operation, water may be drawn from the reservoir to the intake structure which has two chambers. Each chamber discharges water to the 4 foot by 5 foot conduit which flows into a tunnel which transmits water to Morris Reservoir. Water is also discharged to a fountain downstream to maintain minimum flow in the river of 1.5 MGD. Water can also be discharged downstream to the river through two blowoff valves for waste.

1.3 Pertinent Data

a. Drainage Area. The drainage area tributary to Shepaug Reservoir consists of approximately 38.2 square miles of rolling and mountainous terrain. In addition to the reservoir, 5 percent of the basin is made up of lake and swamp area. Elevations in the basin range from about 800 feet to 1670 feet MSL.

The reservoir consists of about 95 acres at the normal (top of spillway) pool elevation. No dwellings are located along the reservoir shores.

b. Discharge at Dam Site.

(1) The outlet works for the reservoir consists of three 30 inch diameter intake conduits at elevations 769 feet, 793 feet and 810 feet for each chamber. Each chamber also has an 8 inch supply line to the downstream fountain at elevation 767 feet, an outlet to the 4 foot by 5 foot conduit at elevation 793 and a 48 inch blow-off to the downstream channel at elevation 769 feet. The conduit transmits water to a tunnel aqueduct which then flows about 3.6 miles underground to Morris Reservoir.

(2) There are no records of maximum discharge at the dam site, however, in August, 1955, a depth of flow of 7.7 feet was measured at the crest of the low spillway. This would give a discharge of approximately 16,130 cfs.

(3) The spillway capacity with a water surface at the top of dam (elevation 827.5) would be approximately 18,725 cfs.

(4) The spillway capacity with the water surface at the test flood elevation of 828.0 feet is approximately 24,850 cfs.

(5) The total project discharge at the test flood elevation of 828.0 feet is 24,850 cfs.

c. Elevation (feet above MSL).

(1) Streambed at centerline of dam - 762.5

(2) Maximum tailwater - N/A

(3) Upstream portal invert diversion tunnel - N/A

(4) Recreation pool - N/A

(5) Full flood control pool - N/A

(6) Spillway crest (permanent spillway) 819 low level and 820 high level.

(7) Design surcharge - unknown

(8) Top dam - 827.5

(9) Test flood surcharge - 828.9

d. Reservoir (miles).

(1) Length of maximum pool - 1.1

(2) Length of recreational pool - N/A

(3) Length of flood control pool - N/A

e. Gross Storage (acre-feet)

(1) Recreation pool - N/A

(2) Flood control pool - N/A

(3) Spillway crest pool - 2037

(4) Top of dam - 2937

f. Reservoir Surface (acres).

(1) Recreation pool - N/A

(2) Flood control pool - N/A

(3) Spillway crest - 92

(4) Test flood pool - 114

(5) Top dam - 112

g. Dam.

(1) Type - Concrete gravity and earth embankment

(2) Length - 500 feet, overall

(3) Height - 65 feet - concrete, 35 feet - earth

(4) Top width - Concrete- 12 feet, earth - varies (18 feet minimum).

(5) Side slopes - Upstream: Concrete 1 in 20 batter, Earth 2:1 - Downstream: Concrete 2 horizontal to 3 vertical, Earth- Varies.

(6) Zoning - None

(7) Impervious core - Concrete corewall indicated on plans.

(8) Cutoff - Excavation to ledge

(9) Grout curtain - Unknown

(10) Other - Unknown

h. Diversion and Regulating Tunnel.

See Section j below.

i. Spillway

(1) Type - Ogee- shaped concrete weir

(2) Length of weir- East (high) - 145.3 feet; West (low) 73.3

(3) Crest elevation - High - 820 feet; Low - 819 feet

(4) Gates - None

(5) Upstream channel - Concrete rectangular channel 218.6 feet wide - 7.5 feet deep east section, 8.5 feet deep west section. Variable width and depth.

(6) Downstream channel - V-shaped channel. North wall is the concrete spillway. South wall is cement rubble masonry.

j. Regulating Outlets. The reservoir can be drained by two 48 inch waste outlet pipes set at approximately elevation 769 feet. These pipes are controlled by 48 sluice gate valves, located at the downstream side of the gate chambers. Three 30 inch water supply intakes feed each chamber. Each chamber has a 36 inch sluice gate feeding the 4 x 5 foot conduit. Each chamber discharges to an 8 inch cast iron pipe which supplies water downstream to a fountain for minimum flow in the river.

SECTION 2
ENGINEERING DATA

2.1 Design

This dam was constructed in 1933 for water supply purposes. A set of plans dated September 1933 as prepared by Robert A. Cairns, City Engineer, City of Waterbury, showing plan, elevation, typical sections and details is available at the office of the owner. No in-depth engineering data were found for this dam.

2.2 Construction

No construction records were available for use in evaluating the dam.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Other than the set of plans described above, no additional engineering data was found to be available.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity. The field investigation indicated that the external features of Shepaug Reservoir Dam substantially agree with those on the available plans.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Shepaug Reservoir Dam was made on December 6, 1978. The inspection team consisted of personnel from Philip W. Genovese & Associates, Inc. and Geotechnical Engineers, Inc. Representatives of the City of Waterbury, Bureau of Water were also present during portions of the inspection. Inspection checklists, completed during the visual inspection are included in Appendix A. At the time of the inspection, the water level was approximately 7.3 feet below the permanent spillway elevation. No water was passing over the spillway. The upstream face of the dam could only be inspected above this water level.

b. Dam. The dam consists of a concrete gravity section about 390 feet long and an embankment section about 110 feet long. The crest is at elevation 827 according to the design drawings.

According to the design drawings, the entire section is founded on bedrock. The appearance of bedrock outcrops at several locations near the downstream toe is consistent with the design drawings in this respect.

Visual inspection of the embankment section showed no signs of distress and no seepage was observed at the downstream toe.

An erosion feature has developed on the intermediate berm of the downstream slope adjacent to the tunnel entrance which has created a 12 inch depression on the berm crest and a slight bulge on the slope beneath the depression.

Minor sloughing of the embankment on the downstream slope about 60 feet left (east) of the gatehouse was observed. Discussion with Water Company personnel indicate the sloughing is attributed to grass cutting procedures.

Three minor seeps were indicated near the downstream toe of the middle one-third of the concrete spillway section. Areas of wet concrete were observed but there were no observable flows.

It would not have been possible to identify any seeps that may occur in the deepest part of the valley because of the tail water at the downstream toe at the time of inspection.

There is limited information in the available design drawings as to indicate the embankment section is founded on bedrock.

c. Appurtenant Structures. Visual inspection of the concrete spillway, spillway channel and outlet works did not reveal any evidence of stability problems. The concrete surface and construction joints appeared to be in good condition with the exception of the spillway surface which is badly spalled and indicates seepage at the downstream toe. See Photos 2 and 3. The right side of the spillway is located on bedrock as seen in Photo 5.

The spillway structure, shown in Photos 2 and 10 consists of an ogee-shaped weir with training walls of concrete, cement rubble masonry and bedrock. The concrete spillway surface is in fair condition.

The outlet works consists of an inlet channel, a service gate chamber (containing two identical chambers) with 5 control gates in each chamber and a 4 foot by 5 foot conduit. As the intake structure was below water, it was not inspected. Of the five gates located in the gate chamber, three control inlet and two control outlet. The intake conduits are located at elevation 769, 793 and 810. The gatehouse can be seen in Photo 1. The discharge conduits, 36 inch for water supply and 48 inch for blowoff are located at elevation 793 and 769 respectively. As all gates were below water in the gate chamber, they could not be inspected. However, all parts of the gate chamber that could be inspected appeared to be in good condition. All gates are reported to be operational.

The spillway discharge channel is generally in good condition. The channel is shown in Photos 2, 3 and 10.

d. Reservoir Area. The reservoir area has rolling and mountainous terrain, partially wood covered. A more detailed description of the drainage area is included in Section 1.3 of this report. There was no development observed along the shoreline.

e. Downstream Channel. Water flowing over the spillway goes down the spillway channel a maximum distance 180 feet before entering the downstream channel. Two blowoff pipes and the 8 inch fountain discharge directly to the downstream channel. The channel walls are cement rubble masonry as may be seen in Photo 4.

3.2 Evaluation

Visual examination indicates that the embankment is in good condition. An indication of seepage was observed from the toe of the

concrete spillway section of the dam. The inspection revealed the following:

a. An erosion feature on the intermediate tier of the downstream slope adjacent to the tunnel entrance.

b. Minor sloughing of the downstream slope of the embankment about 60 feet east of the gatehouse.

c. Wet concrete areas near the downstream toe of the spillway in the central portion.

d. Spalling of the concrete spillway.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure

The Shepaug Reservoir Dam creates an impoundment which is used as a water supply source for the City of Waterbury. The normal operational procedure is to draw water from the reservoir and pipe it approximately 3.6 miles to the Morris Reservoir. Water is also discharged to the Shepaug River through a fountain to maintain minimum flow requirements.

4.2 Maintenance of Dam

This dam is visited on a frequent basis by personnel of the City of Waterbury, Bureau of Water. These visits are primarily for surveillance of the reservoir for water quality control purposes. General maintenance is accomplished during these visits.

4.3 Maintenance of Operating Facilities

Maintenance on the operating facilities is done on a regular basis.

4.4 Description of Warning Systems

There are no warning systems in effect at this facility.

4.5 Evaluation

The current operating and maintenance procedures for the dam are to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure as well as establishing a warning system to follow in event of flood flow conditions or imminent dam failure.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

Shepaug Reservoir Dam consists of a 390 feet long concrete gravity section including a 218.6 feet long spillway and a 110 feet long embankment section. The maximum structural height of the dam is 65 feet. Appurtenant structures other than the spillway consist of a spillway channel and an outlet works. The spillway consists of two levels, one being 73.3 feet long at elevation 819 and the other 145.3 feet long at elevation 820. The outlet works consists of an inlet channel, a service gate chamber containing two chambers and outlet conduits that discharge to a water supply tunnel or the downstream river channel. Intake conduits are at elevations 769, 793 and 810. Discharge conduits are elevations 769 and 793. Shepaug Reservoir Dam is classified as being intermediate in size having a maximum storage of 2937 acre-feet.

a. Design Data. No hydrologic or hydraulic design data were disclosed for this dam.

b. Experience Data. The maximum discharge at this dam site is unknown. The maximum observed condition was reported to be 7.7 feet over the spillway or about 16,130 cfs.

c. Visual Observations. No evidence of damage to any portion of the project from overtopping was visible at the time of the inspection.

d. Test Flood Analysis. As no detailed design and operational information are available, hydrologic evaluation was performed using dam information gathered by field inspection, watershed size and an estimated test flood equal to 1/2 Probable Maximum Flood (PMF) as determined by guide curves issued by the Corps of Engineers. Based on a drainage area of 38.2 square miles, it was estimated that the test flood flow at this dam would be 26,263 cfs. Following the guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharges results in a test flood discharge of 24,850 cfs. As the maximum spillway capacity at the top of the dam is 18,725 cfs, the spillway will not pass the test flood without overtopping the dam.

e. Dam Failure Analysis. The impact of failure of the dam at maximum pool (top of dam) was assessed using the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers.

A major breach of dam would probably result in an additional downstream flood stage 1.1 mile downstream in Woodville of 37 feet. Structures that could be affected by the flood wave would include about 12 houses, 3 of which are close to the river and one is essentially at the grade of the river. A flood of this magnitude could cause substantial damage and loss of life.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examination did not disclose any immediate stability problems. Routine maintenance should be sufficient to prevent any long-term problems.

b. Design and Construction Data. Design drawings are available for the dam. They include general information regarding the overall dimensions of the dam and the appurtenances. This information is not sufficient to assess the stability of the dam and the safety must be judged primarily from visual observations. Grouting of the bedrock was required by the contract documents but the details are not available.

c. Operating Records. No operating records pertinent to the structural stability of the dam were available.

d. Post Construction Changes. Since original construction was completed in about 1933, no apparent revisions have been made.

e. Seismic Stability. The dam is located in Seismic Zone 1, and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that the dam is in good condition. The inspection revealed:

(1) An erosion feature on the intermediate berm of the downstream slope adjacent to the tunnel entrance.

(2) Minor sloughing of the downstream slope of the embankment about 60 feet left (east) of the gatehouse.

(3) Wet concrete areas near the downstream toe in the center one-third of the spillway section.

(4) Spalling of concrete on the spillway.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency. This dam is in good condition. The recommendations and remedial measures described in Sections 7.2 and 7.3 should be accomplished within one year after receipt of this Phase I Inspection Report by the owner.

d. Need for Additional Investigation. The findings of this inspection indicate that there is need for additional investigations.

7.2 Recommendations

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, further engineering studies should be made to determine spillway adequacy and/or the ability of the project to withstand some overtopping during a major flood event.

7.3 Remedial Measures

a. The erosion feature on the embankment near the tunnel entrance should be repaired.

b. The area of the downstream slope which experiences minor sloughing because of grass mowing should be regraded and

planted with appropriate cover to stabilize the slope.

c. The spillway section should be repaired where wet concrete areas were observed and spalling has occurred.

d. The owner should establish an operational procedure and formal warning system to follow for emergency conditions.

e. The owner should develop a biennial technical inspection program.

7.4 Alternatives

There is no practical alternative to the recommendations in Sections 7.2 and 7.3.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT: SHEPAUG DAM

DATE: December 6, 1978

TIME: 1130

WEATHER: Sunny - 45°- 50°

W.S. ELEV. 811.7' U.S. ____ DN.S.

PARTY:

1. Bob Jones Party Chief
2. Don Ballou Hydraulics/Hydrology
3. Karl Dalenberg Geotechnical
4. Dick Murdock "
5. Leonard Assard Owner's Rep.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Earthen Dam Embankment NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	DAM EMBANKMENT	
BJ	Crest Elevation	827.5' USGS
BJ	Current Pool Elevation	811.7' USGS
BJ	Maximum Impoundment to Date	826.75' USGS
GEI	Surface Cracks	None observed
GEI	Pavement Condition	Gravel road surface
GEI	Movement or Settlement of Crest	None observed
GEI	Lateral Movement	None
GEI	Vertical Alignment	Good
GEI	Horizontal Alignment	Good
GEI	Condition at Abutment and at Concrete Structures	Good
GEI	Indications of Movement of Structural Items on Slopes	None
GEI	Trespassing on Slopes	None
GEI	Sloughing or Erosion of Slopes or Abutments	None observed
GEI	Rock Slope Protection- Riprap Failures	Good, no failures
GEI	Unusual Movement or Cracking at or Near Toe	None observed
GEI	Unusual Embankment or Downstream Seepage	None observed
GEI	Piping or Boils	None observed
GEI	Foundation Drainage Features	None
GEI	Toe Drains	None
GEI	Instrumentation System	None
GEI	Vegetation	None

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Concrete Dam Embankment NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	DIKE EMBANKMENT	
BJ	Crest Elevation	827.5 USGS
BJ	Current Pool Elevation	811.7 USGS
BJ	Maximum Impoundment to Date	826.75' USGS
GEI	Surface Cracks	Some on top
GEI	Pavement Condition	
GEI BJ	Movement or Settlement of Crest	None observed
GEI BJ	Lateral Movement	None observed
GEI BJ	Vertical Alignment	Good
GEI BJ	Horizontal Alignment	Good
GEI	Condition at Abutment and at Concrete Structures	
GEI	Indications of Movement of Structural Items on Slopes	
GEI	Trespassing on Slopes	
GEI	Sloughing or Erosion of Slopes or Abutments	
GEI	Rock Slope Protection- Riprap Failures	
GEI	Unusual Movement or Cracking at or Near Toes	
GEI	Unusual Embankment or Downstream Seepage	
GEI	Piping or Boils	
GEI	Foundation Drainage Features	
GEI BJ	Toe Drains	None
GEI BJ	Instrumentation System	None
GEI	Vegetation	

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Outlet Works Intake NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Under water, not observable
GEI Slope Conditions	
GEI Bottom Conditions	
GEI Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
GEI Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Outlet Works- Tower NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - CONTROL TOWER	
	a. Concrete and Structural	
BJ	General Condition	Good
	Condition of Joints	
BJ	Spalling	None
BJ	Visible Reinforcing	None
BJ	Rusting or Staining of Concrete	Some stain
BJ	Any Seepage or Efflorescence	None observed
BJ	Joint Alignment	Good
BJ	Unusual Seepage or Leaks in Gate Chamber	None
BJ	Cracks	Minor
BJ	Rusting or Corrosion of Steel	None
	b. Mechanical and Electrical	
	Air Vents	
	Float Wells	
	Crane Hoist	
	Elevator	
	Hydraulic System	
	Service Gates	
	Emergency Gates	
	Lightning Protection System	
	Emergency Power System	
	Wiring and Lightning System	

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS- TRANSITION AND CONDUIT	
General Condition of Concrete	None observed
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

BJ

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Outlet Works- Structure Channel NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS- OUTLET STRUCTURE AND OUTLET CHANNEL	
	General Condition of Concrete	
	Rust or Staining	
	Spalling	
	Erosion or Cavitation	
	Visible Reinforcing	
	Any seepage or Efflorescence	
	Condition at Joints	
GEI	Drain holes	None observed
B GEI	Channel	V-shaped concrete & masonry walls
GEI	Loose Rock or Trees Overhanging Channel	None
GEI	Condition of Discharge Channel	Good

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

PROJECT FEATURE Outlet Works - Spillway Weir, Channel NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
	a. Approach Channel	
GEI	General Condition	Partially under water, right side at abutment is good.
GEI	Loose Rock Overhanging Channel	None observed
GEI	Trees Overhanging Channel	None observed
GEI	Floor of Approach Channel	Irregular bedrock surface at abutment
	b. Weir and Training Walls	
BJ	General Condition of Concrete	Fair to poor
BJ	Rust or Staining	Some
BJ	Spalling	Common at crest
BJ	Any Visible Reinforcing	None observed
	Any Seepage or Efflorescence	3 minor wet spots at base of spillway concrete section
GEI	Drain Holes	None observed
	c. Discharge Channel	
GEI	General Condition	Good
GEI	Loose Rock Overhanging Channel	None observed
GEI	Trees Overhanging Channel	None
GEI	Floor of Channel	Irregular bedrock surface w/some areas filled w/concrete
GEI	Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT: SHEPAUG DAM DATE December 6, 1978

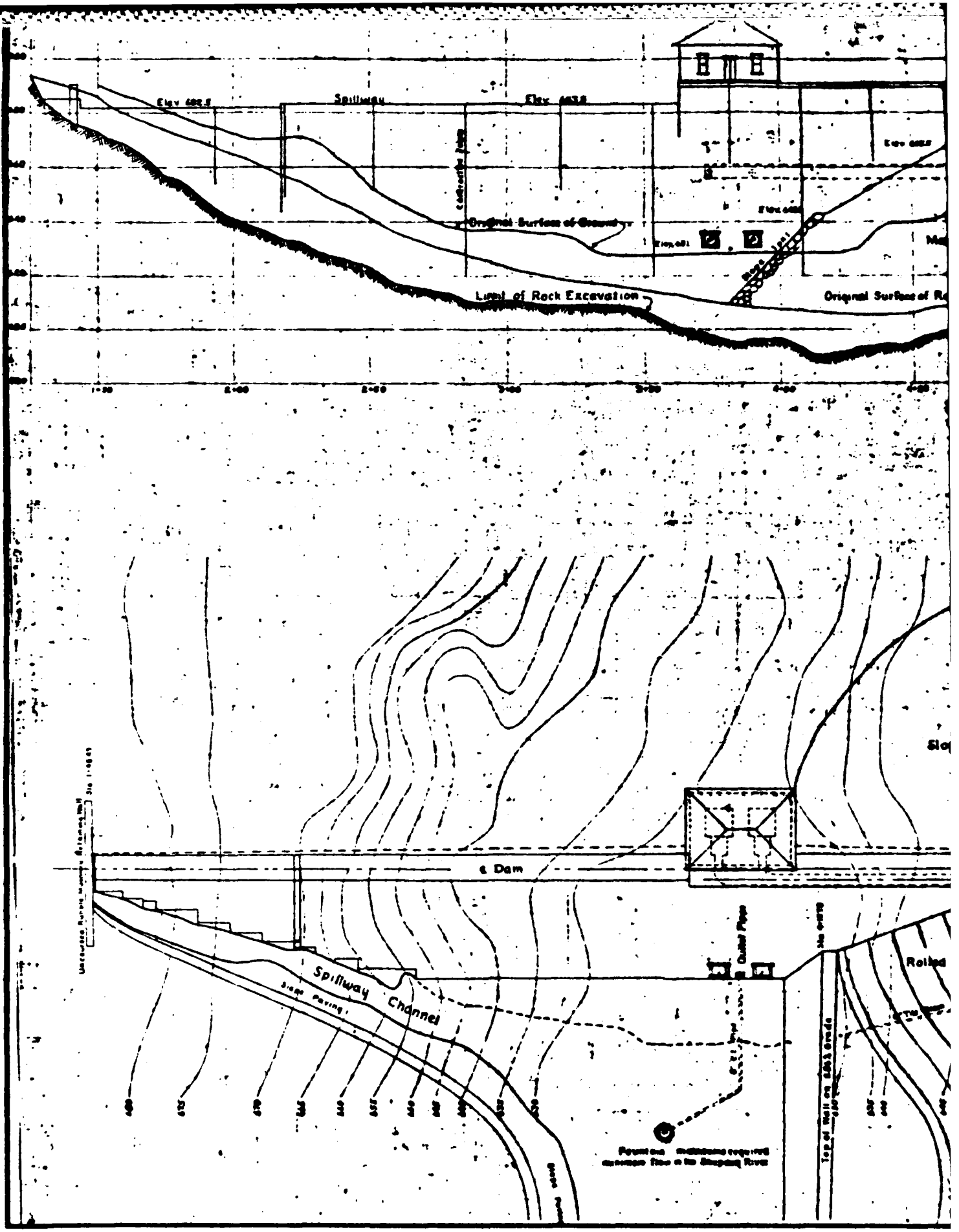
PROJECT FEATURE Outlet Works NAME

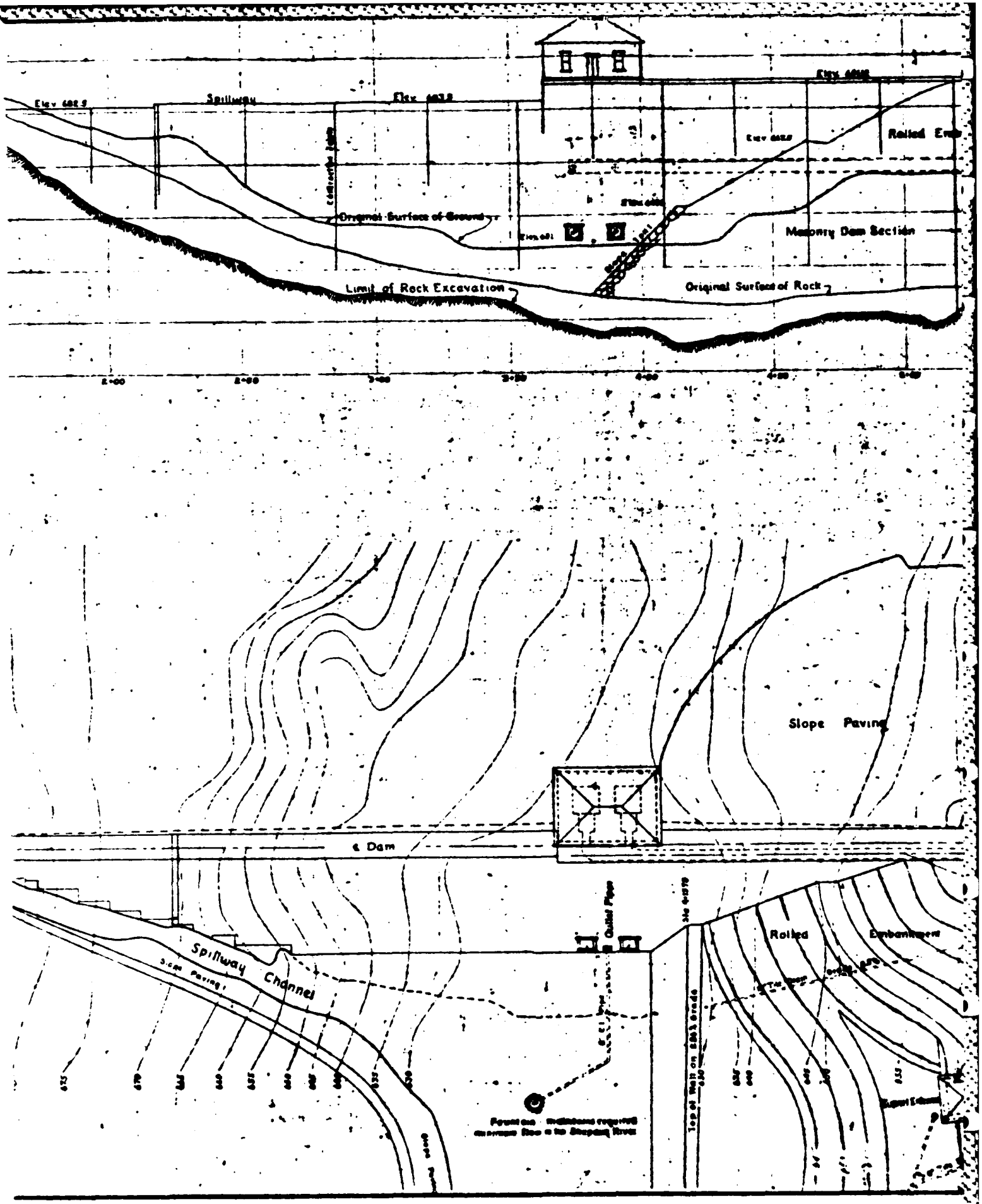
DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS- SERVICE BRIDGE	None
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

APPENDIX B

ENGINEERING DATA


Spillway
Original Surface of Ground
Limit of Rock Excavation
Spillway Channel
Outlet Pipe


Spillway
Original Surface of Ground
Masonry Dam Section
Limit of Rock Excavation
Original Surface of Rock
Slope Paving
Spillway Channel
Rolled
Embankment

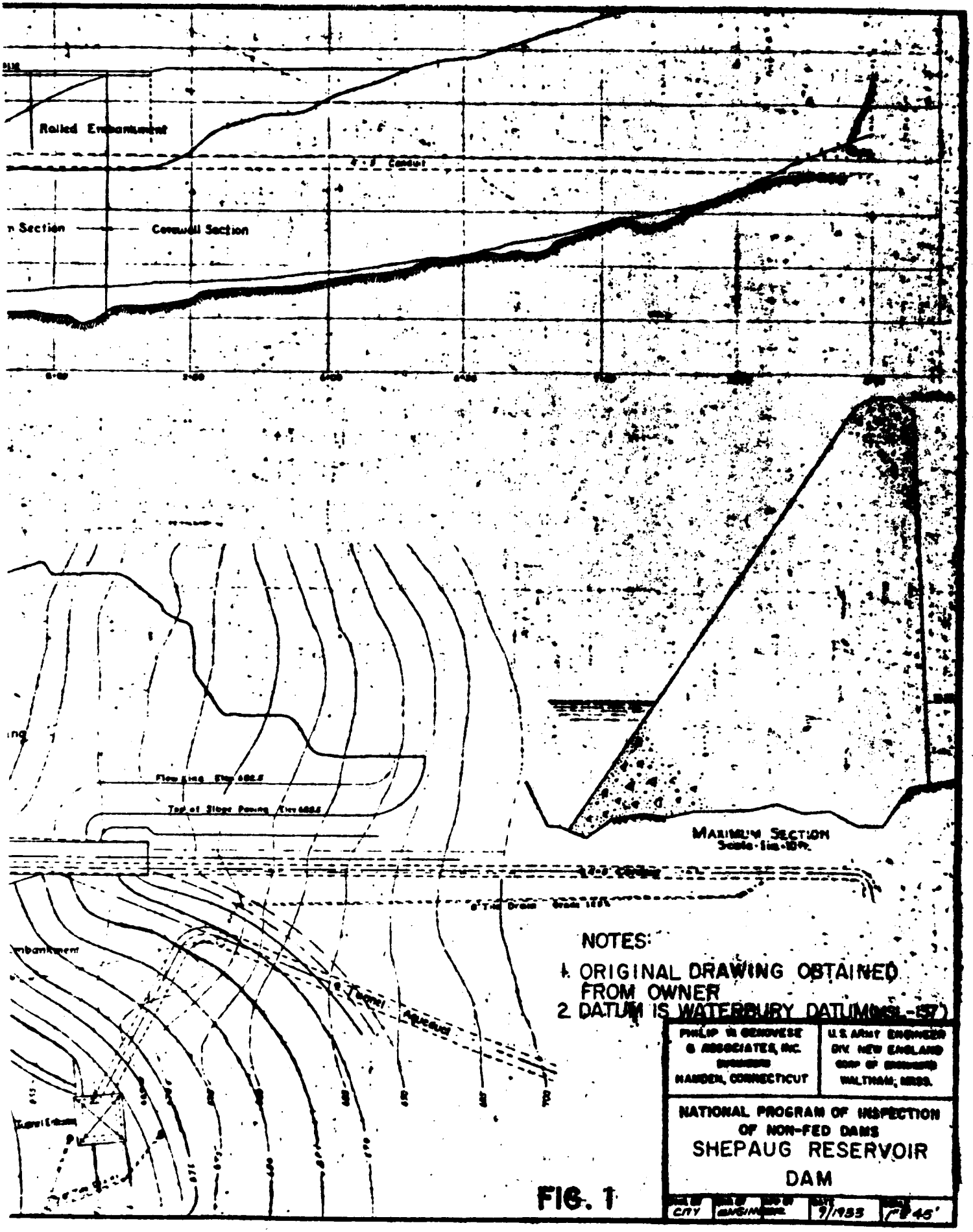
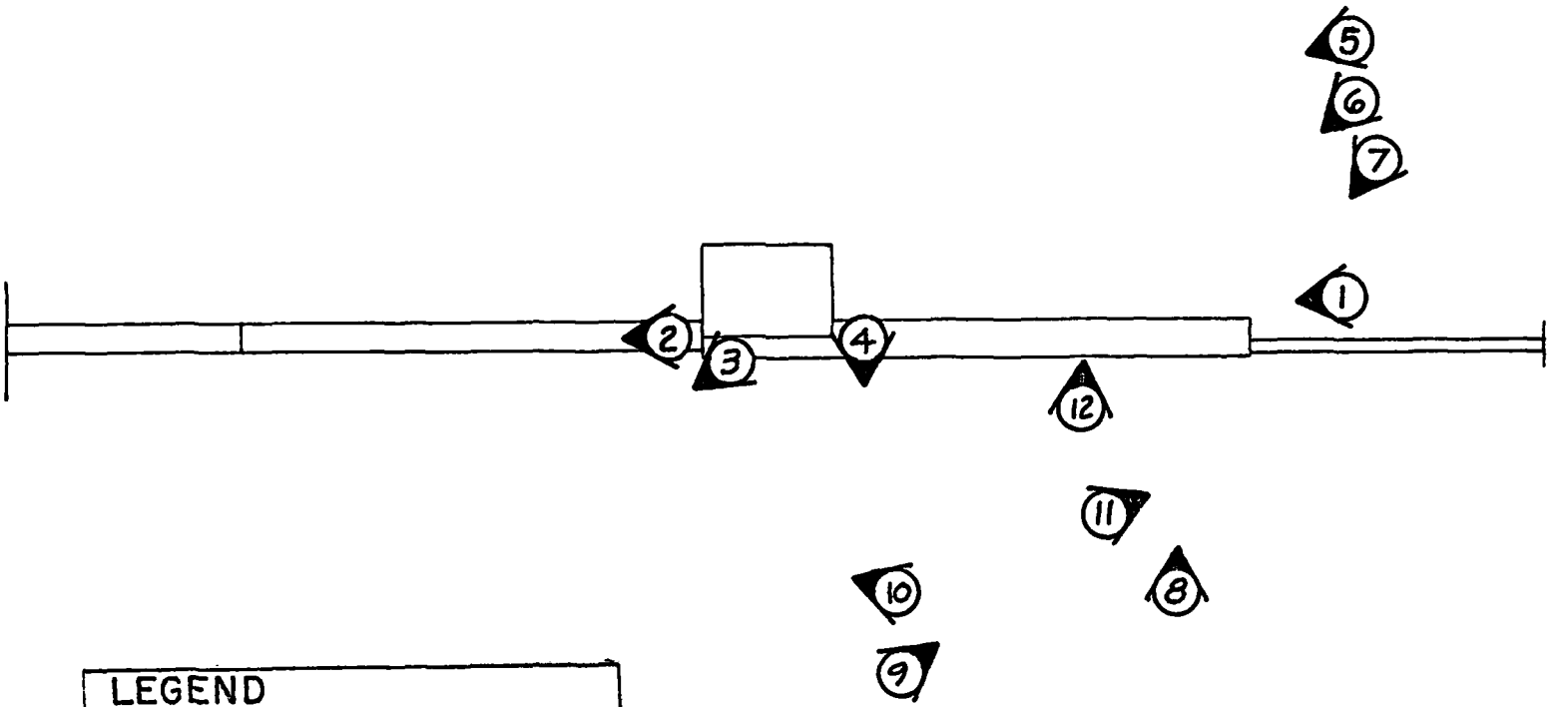

Raised Embankment
Cutoff
n Section
Cutwall Section
Flow Line
Top of Slope Paving
MAXIMUM SECTION
Scale: 1in.=10ft.
NOTES:
1. ORIGINAL DRAWING OBTAINED FROM OWNER
2. DATUM IS WATERBURY DATUM (MSL-57)
PHILIP M. GENOVESE & ASSOCIATES, INC.
ENGINEERS
HAMDEN, CONNECTICUT
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
SHEPAUG RESERVOIR
DAM
CITY
9/1955

FIG. 1

13

APPENDIX C

PHOTOGRAPHS



LEGEND

4 NUMBER REFERS TO CAPTION. ARROW INDICATES DIRECTION OF PHOTOGRAPH.

N

PHILIP W. GENOVESE & ASSOCIATES, INC. ENGINEERS HAMDEN, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORP OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

SHEPAUG RESERVOIR DAM

DWN. BY	CKD. BY	APP. BY	DATE	SCALE
MJS	NRS	RLJ	2/21/79	N.T.S.

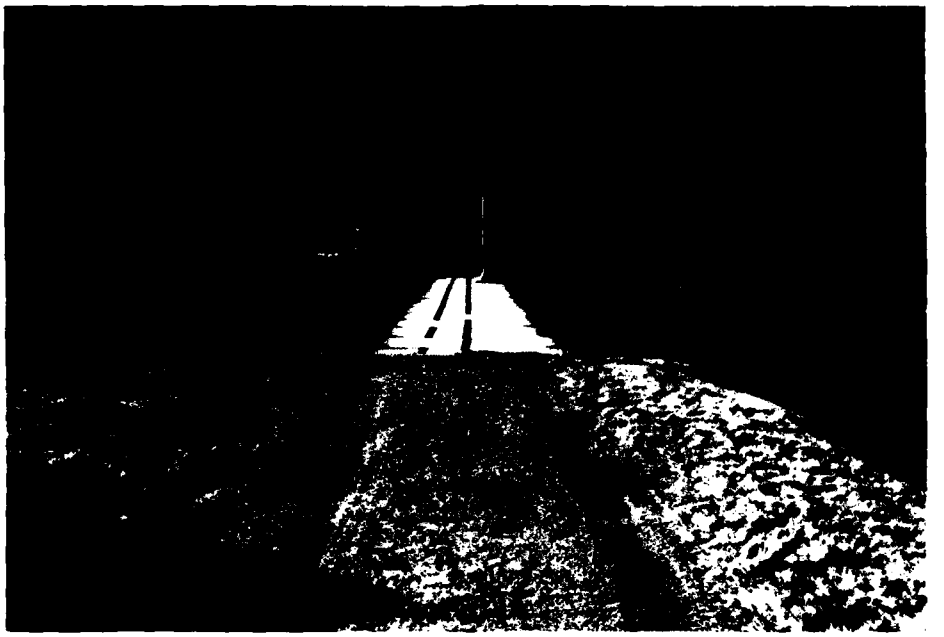
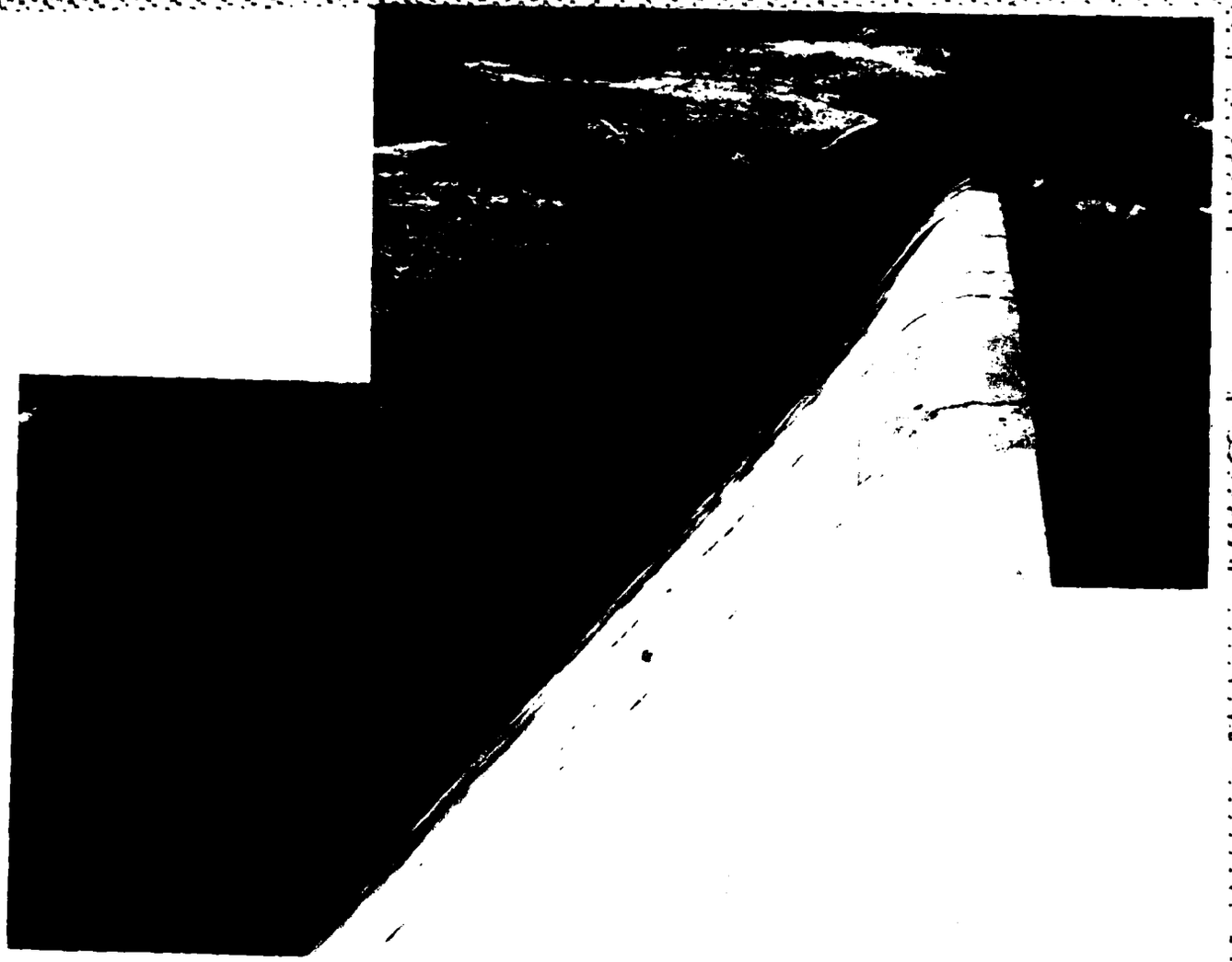


PHOTO NO. 1 - Looking right (west) along crest of dam from area of left (east) abutment.



PHOTOS NO. 2 and 3 - Looking toward right (west) side of spillway from gatehouse.

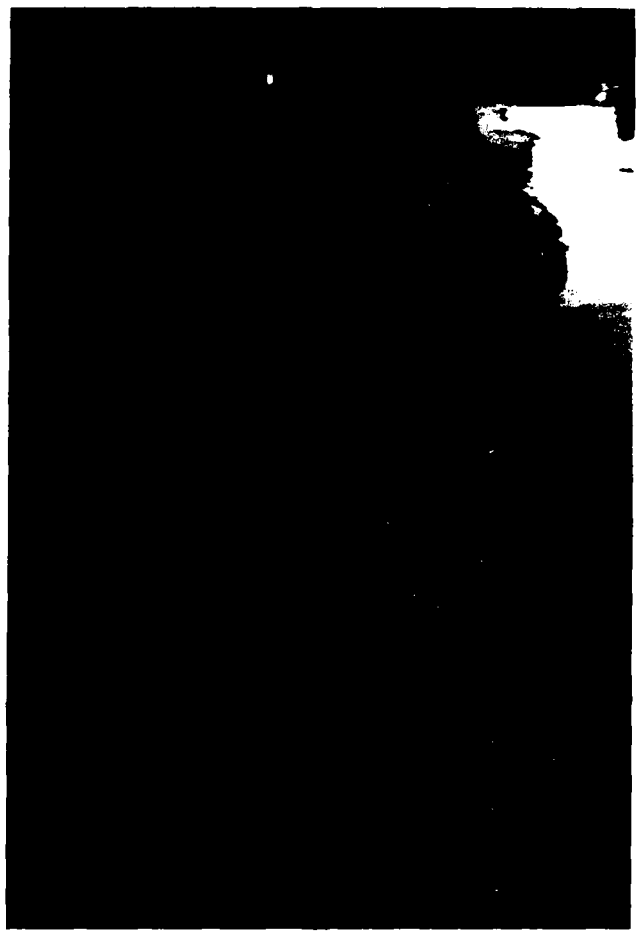
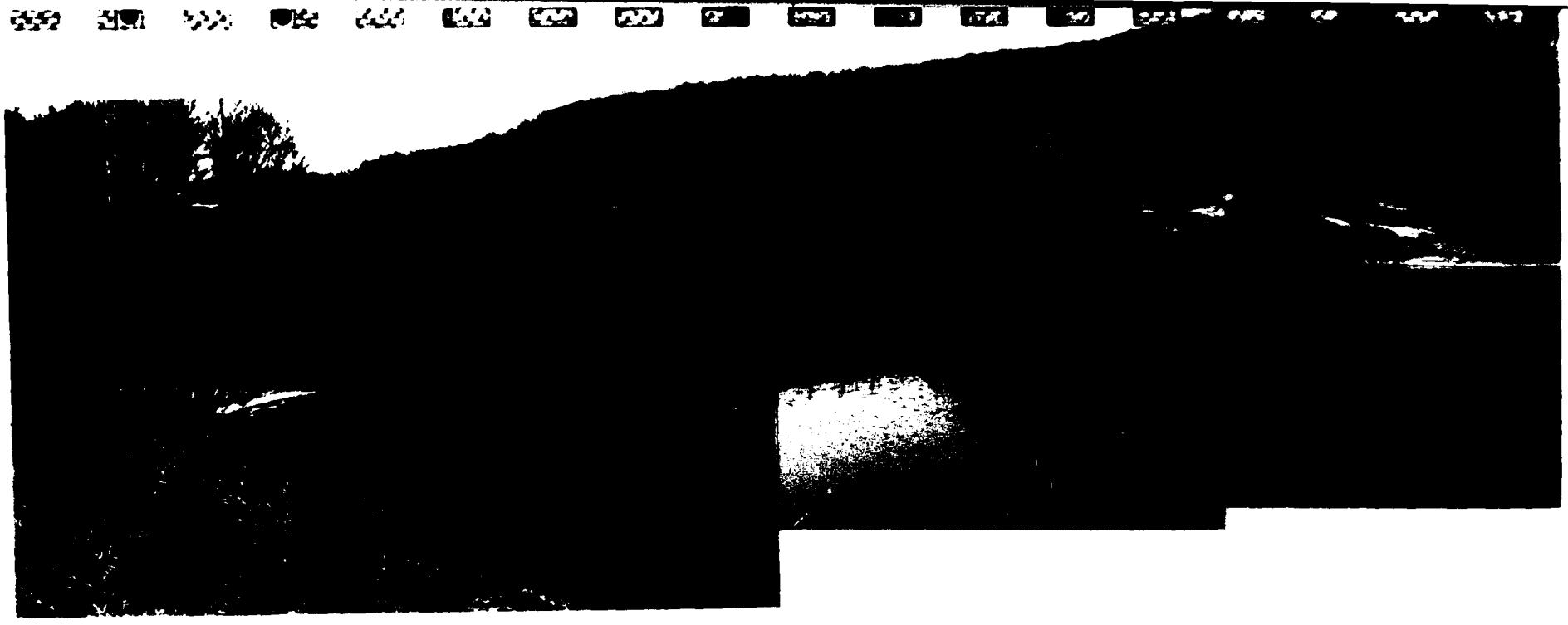


PHOTO NO. 4 - Looking downstream along spillway channel from crest at gatehouse.



PHOTOS 5, 6, and 7 - Panorama of three shots of the upstream face of the dam. There is a rock outcrop on the right abutment.

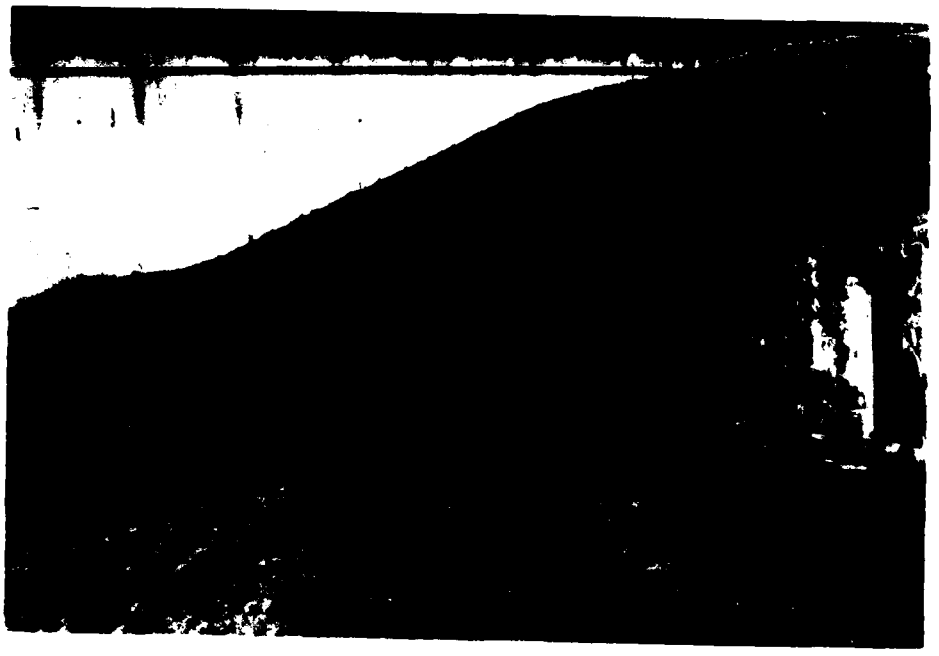


PHOTO NO. 8 - Looking upstream from approximately 75 feet downstream of earth embankment in area of tunnel entrance.

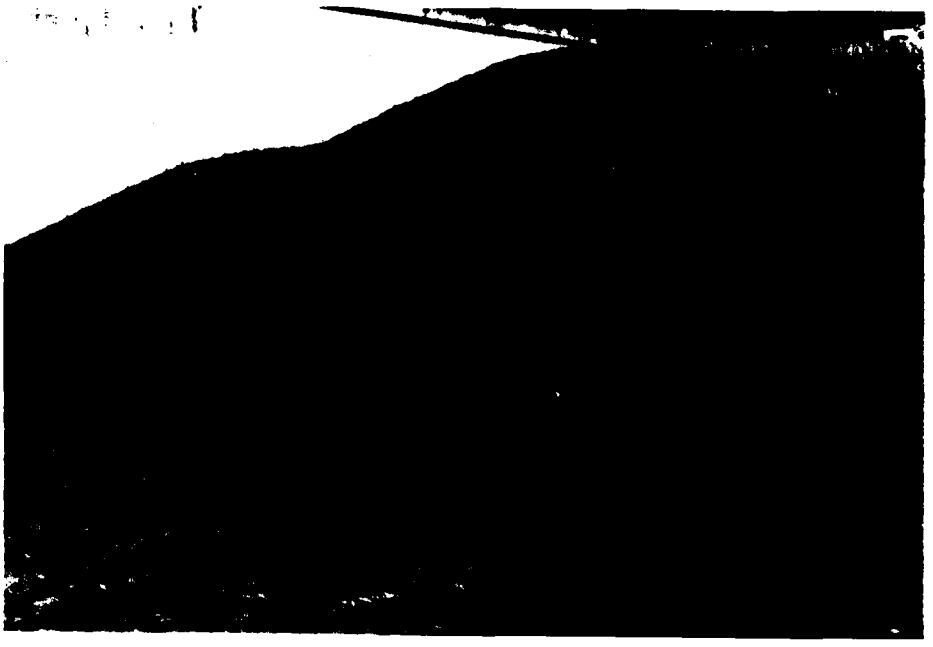


PHOTO NO. 9 - Looking upstream at earth embankment from approximately 75 feet downstream of dam along left (east) edge of outlet channel.

PHOTO NO. 10 - Looking upstream at spillway weir from approximately 100 feet downstream of concrete section along left (east) edge of outlet channel.

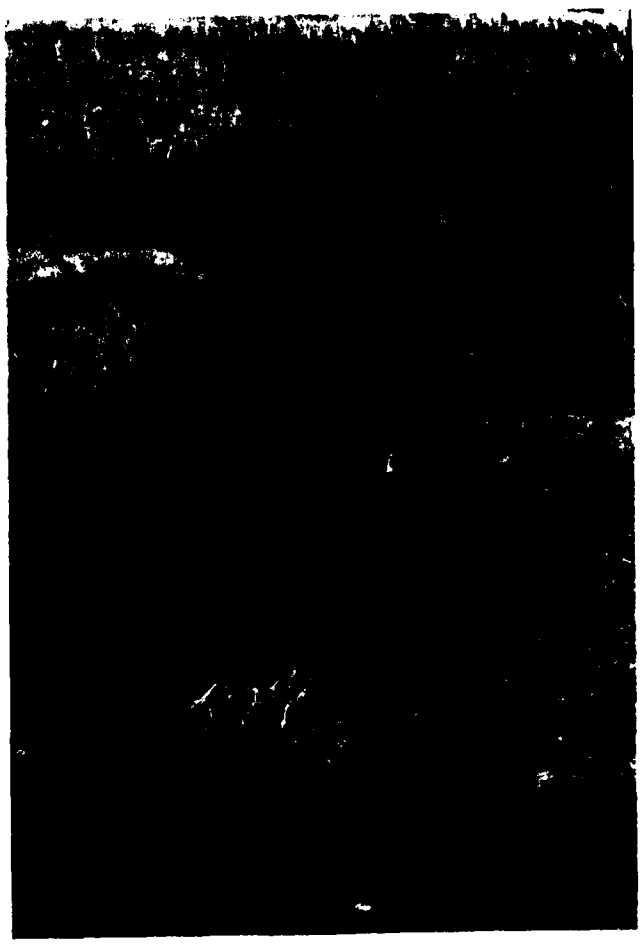


PHOTO NO. 11 Close-up of erosion features approximately 2-3 feet wide, leading down from first berm adjacent to entrance to access tunnel.

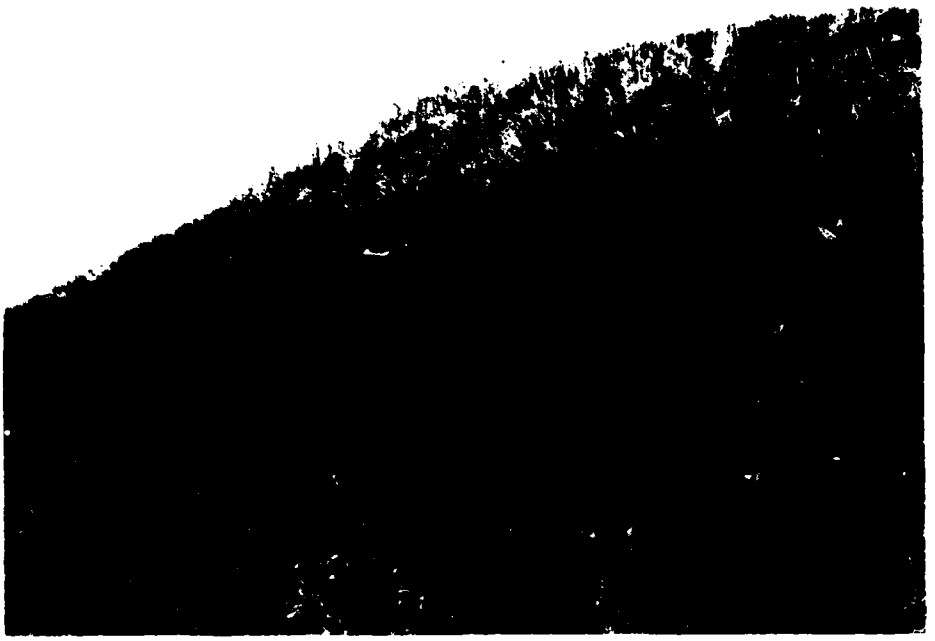
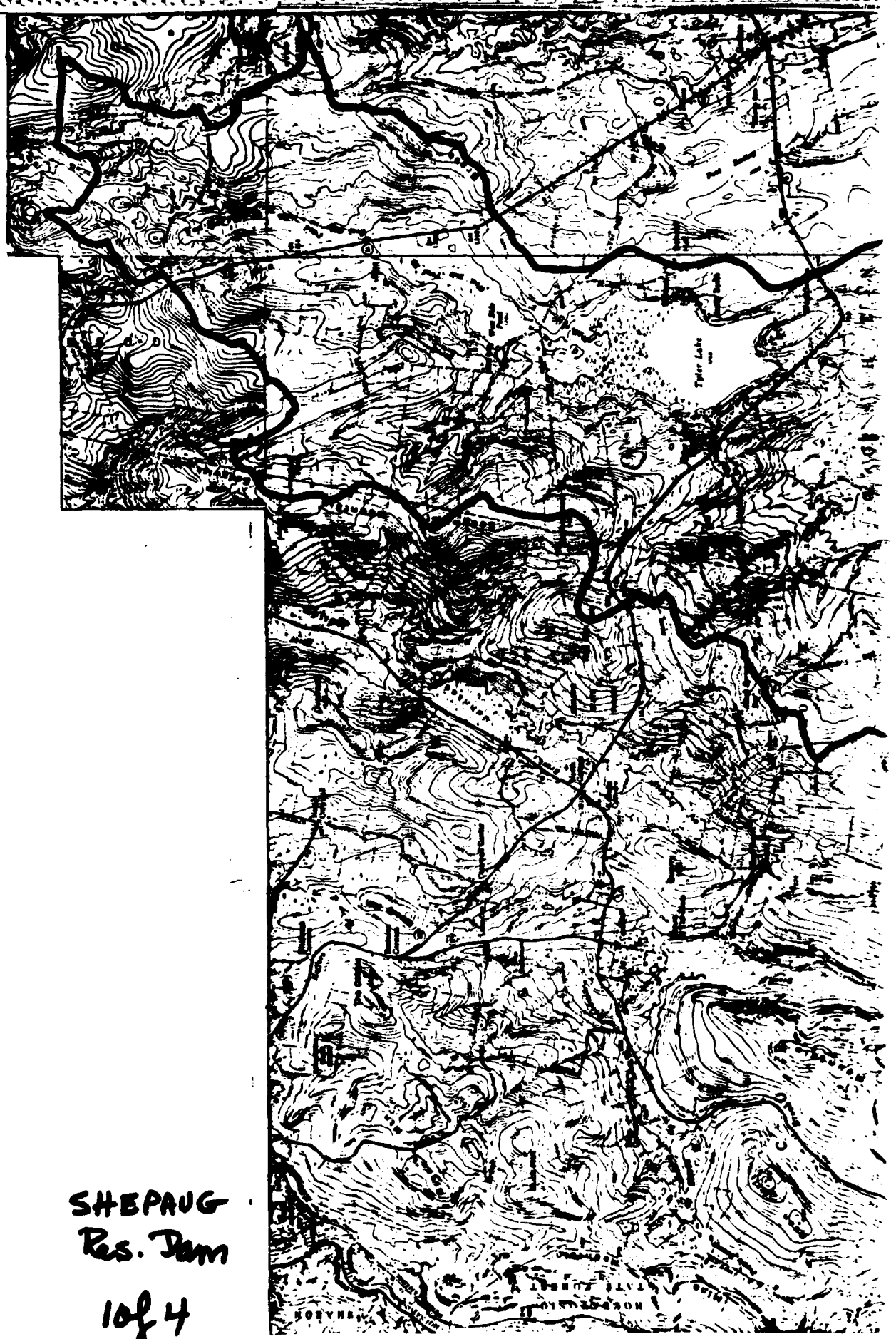


PHOTO NO. 12 - Minor slough of embankment adjacent to dam, approximately 75 feet left (east) of gatehouse.

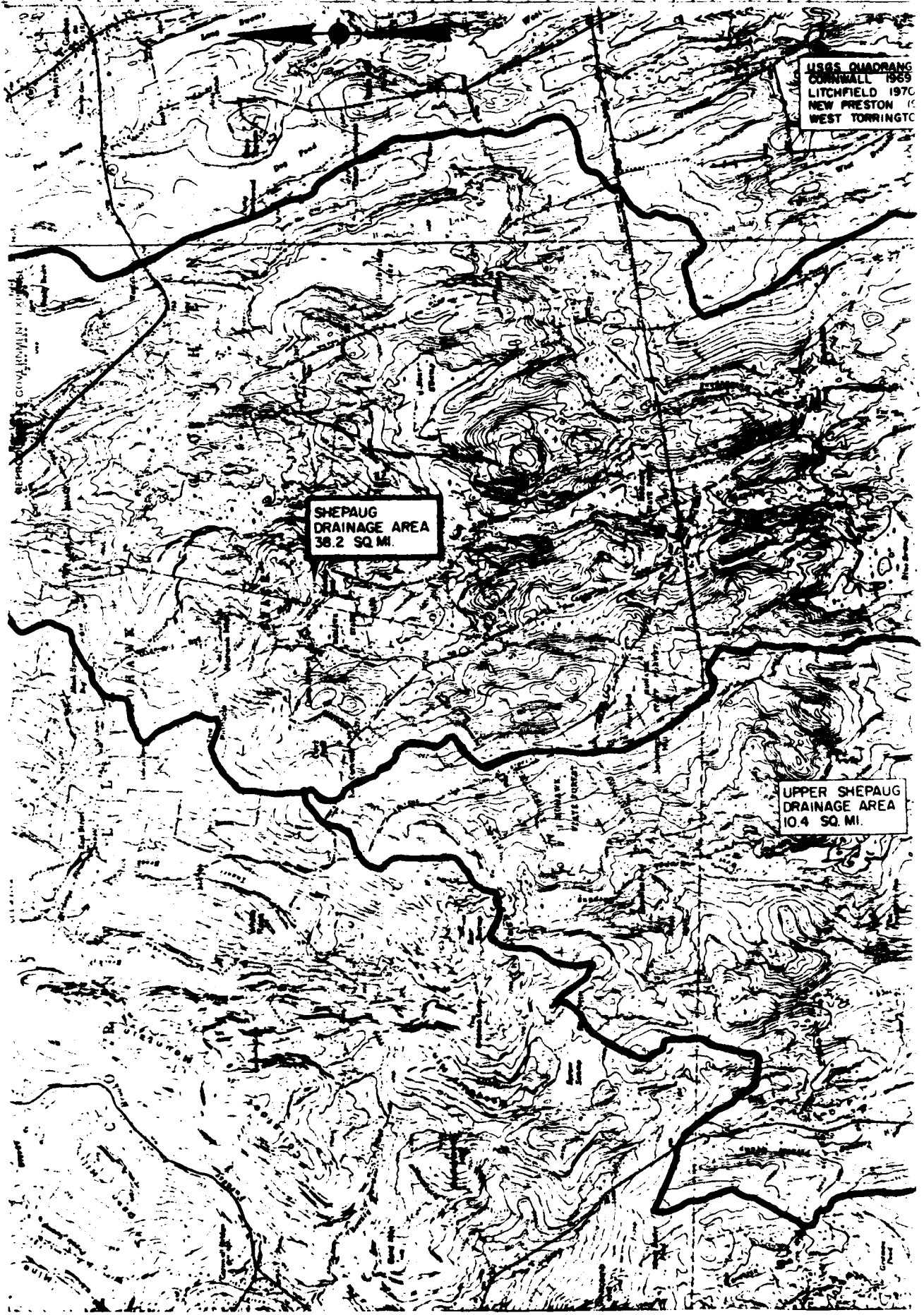
APPENDIX D

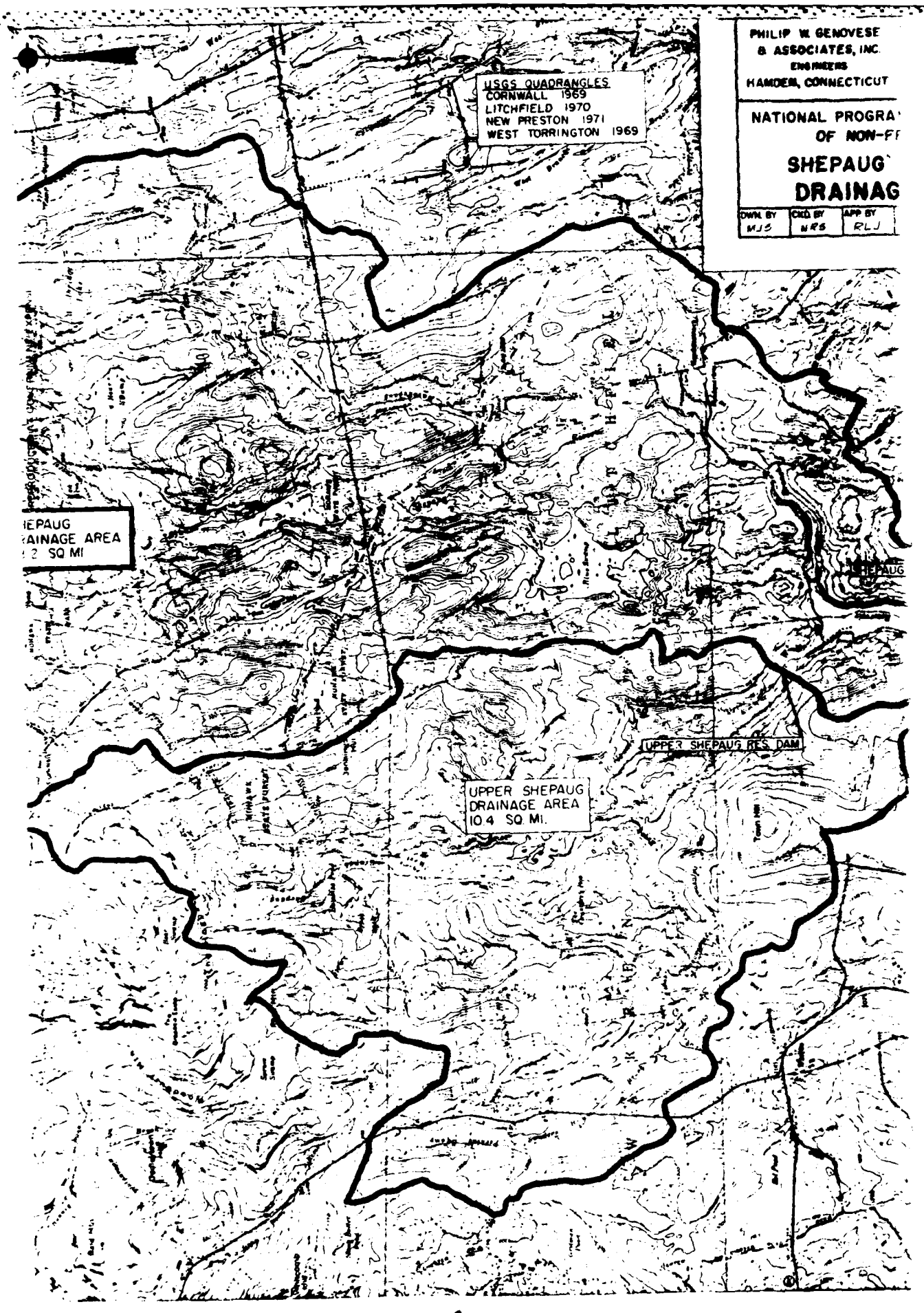
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

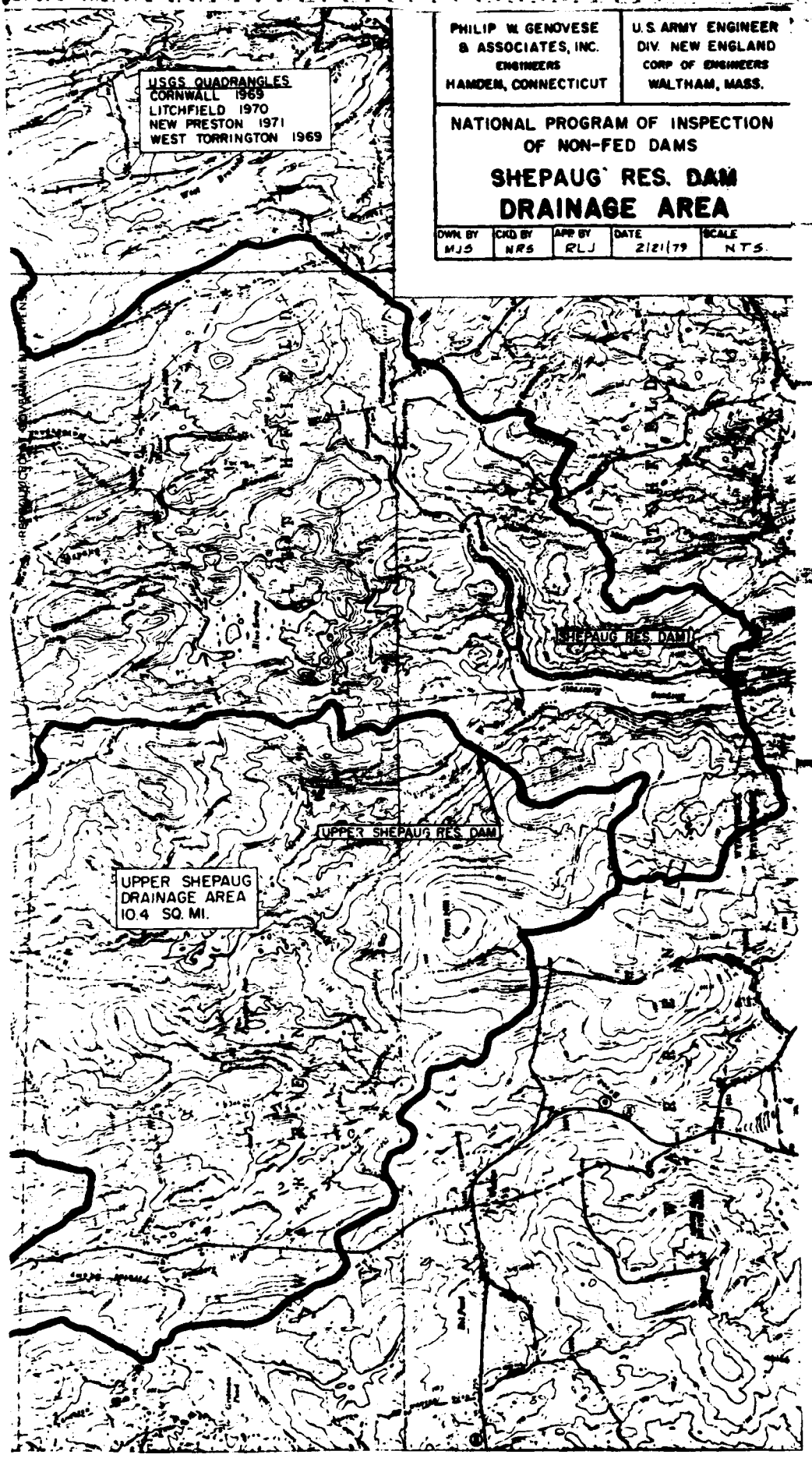


SHEPAUG
Res. Dam

1 of 4


USGS QUADRANG
CORNWALL 1969
LITCHFIELD 1970
NEW PRESTON (
WEST TORRINGTO
SHEPAUG
DRAINAGE AREA
38.2 SQ. MI.
UPPER SHEPAUG
DRAINAGE AREA
10.4 SQ. MI.


USGS QUADRANGLES
CORNWALL 1969
LITCHFIELD 1970
NEW PRESTON 1971
WEST TORRINGTON 1969
PHILIP W. GENOVESE
& ASSOCIATES, INC.
ENGINEERS
HAMDEN, CONNECTICUT
NATIONAL PROGRA
OF NON-FF
SHEPAUG
DRAINAG
DWN. BY MJS
CKD. BY MRS
APP BY RLJ
EPAUG
AINAGE AREA
2 SQ MI
UPPER SHEPAUG RES. DAM
UPPER SHEPAUG
DRAINAGE AREA
10.4 SQ. MI.



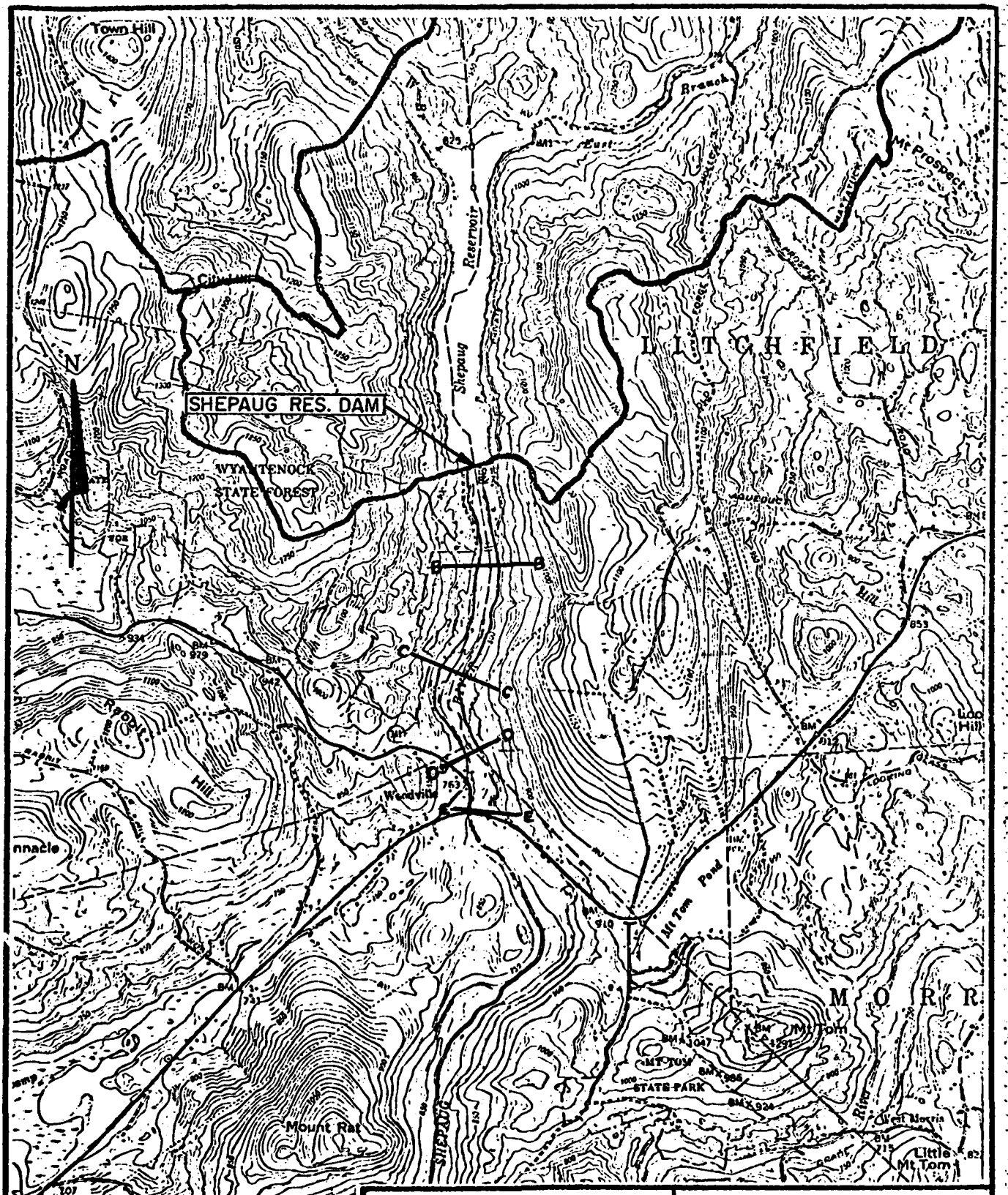
PHILIP W. GENOVESE & ASSOCIATES, INC. ENGINEERS HAMDEN, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORP OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

SHEPAUG RES. DAM
DRAINAGE AREA

DWN. BY	CKD. BY	APP. BY	DATE	SCALE
MJS	NRS	RLJ	2/21/79	NTS.

4 of 4



USGS QUADRANGLE
NEW PRESTON 1971

PHILIP W. GENOVESE AND ASSOCIATES, INC.
ENGINEERS-HAMDEN, CT.

U.S. ARMY ENGINEER DIV.
NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

SHEPAUG RES. DAM

DOWNSTREAM HAZARD AREA

Name	Shepaug Reservoir
Location	Warren & Litchfield, Conn.
Drainage Area	24,448 Acres / 38.2 sq-miles
Flow Line	Elev. 819.0
Top of Dam	Elev. 827.5
Dam Height	65 feet
Size & Hazard	Intermediate & High
Test Flood (TF)	PMF
TF Runoff	19.0 inches
TF Peak Discharge	52,525 cfs
TF Volume	38,706 Ac-Ft
Spillway Storage	900 Ac-Ft (No Freeboard)
Qpeak Outflow	50,500 cfs
Stage @ Peak Outflow	Elev 833.2
Spwy Storage @ Peak Outflow	1500 Ac-Ft
Spillway Type	Concrete Ogee
Breaching Qpeak	77,536 cfs
Reach Outflow	57,060 cfs (6800' downstream)
Reach Outflow Flood Level	Elev 749.0 (6800 downstream depth = 37 feet)

Shepaug Reservoir

Feb 1979
By: DT Ballou

Evaluate the "size" & "hazard" classification in order to obtain the design storm magnitude to be utilized as the test flood.

Size Classification

Top of Dam = Elev 827.5
Downstream Low point = Elev 762.5
∴ Height of Dam = 65' feet

Reservoir area @ flow line = 94 acres
hence; estimated volume below the flow line = $\frac{1}{3} bh = \frac{1}{3} \times 94 \times 65 = 2037$ ac-ft

Volume between the flow line & the top of dam = 900 Ac-Ft which yields a total maximum storage capacity of 2937 AC-Ft.

Finally, from Table #1 of O.C.E. guide the size classification is Intermediate

Hazard Potential

The town of Woodville lies approximately 6000 feet downstream of the dam. State Route 25 also crosses the Shepaug River @ the town of Woodville. There are about a dozen houses in the valley between the dam & town. Three of the houses are quite close to the river with at least one house essentially @ river level. A classification of High will be selected.

Spillway Design Storm (SDF) (Test Flood)

From Table #3 of the OCE. guides using a Size classification of intermediate and a hazard classification of High a Test Flood (TF) of PMF is required.

Drainage Area = 38.2 mi (planimetered)

Utilizing data furnished by the Corp of Engineers, N.E.D. and a watershed area of 38.2 sq-miles we obtain:

Terrain	PMF (c.s.m.)	PMF (cfs)
Rolling	1250	47,750
Mountainous	1500	57,300

Select a test flood of PMF that lies halfway between rolling & mountainous.

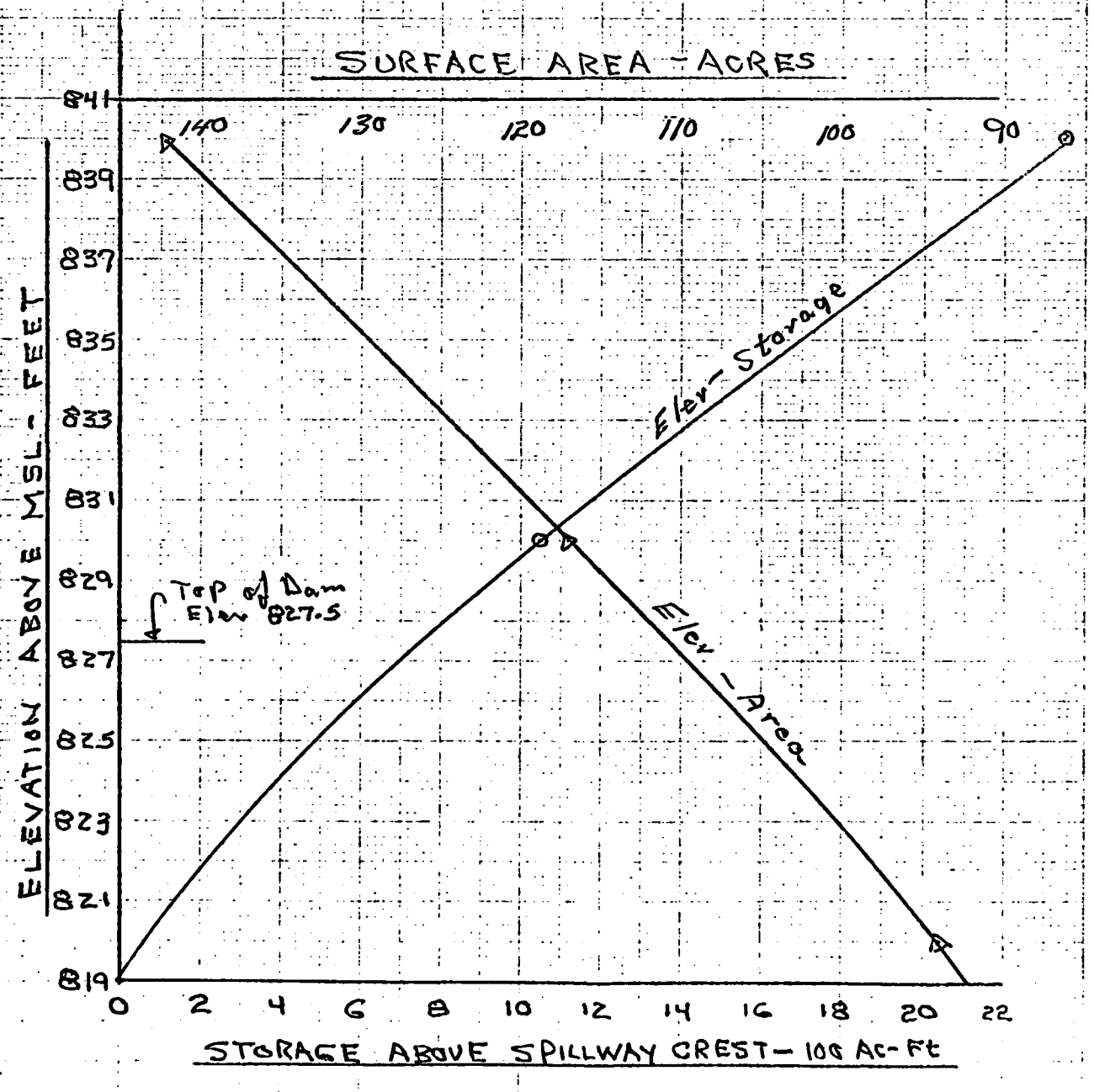
∴ TF = 52,525 cfs (Test flood)

Volume of TF = (53.3 Ac-Ft/in/mi)(38.2 mi)(19") ← R.O. (PMF)
= 38,706 Ac-Ft

Note: There is 900 Ac-Ft available storage between spwy crest & Top of Dam.

Shepaug Reservoir

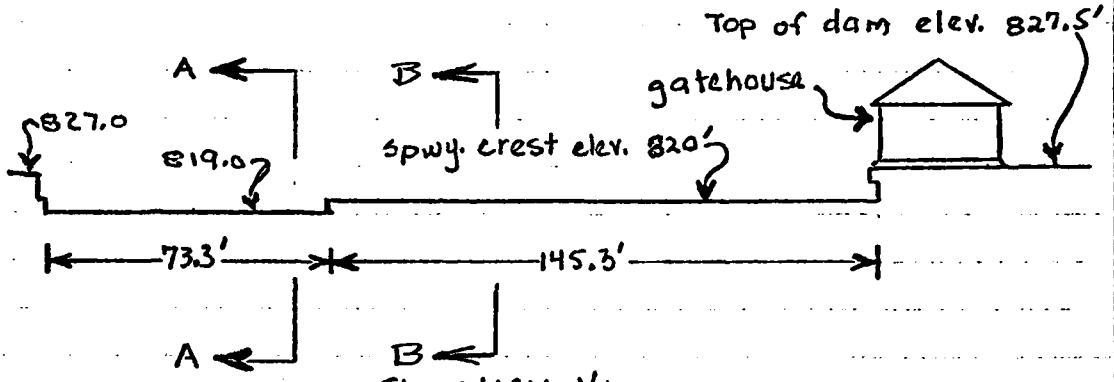
By DT Sallee
May 1979



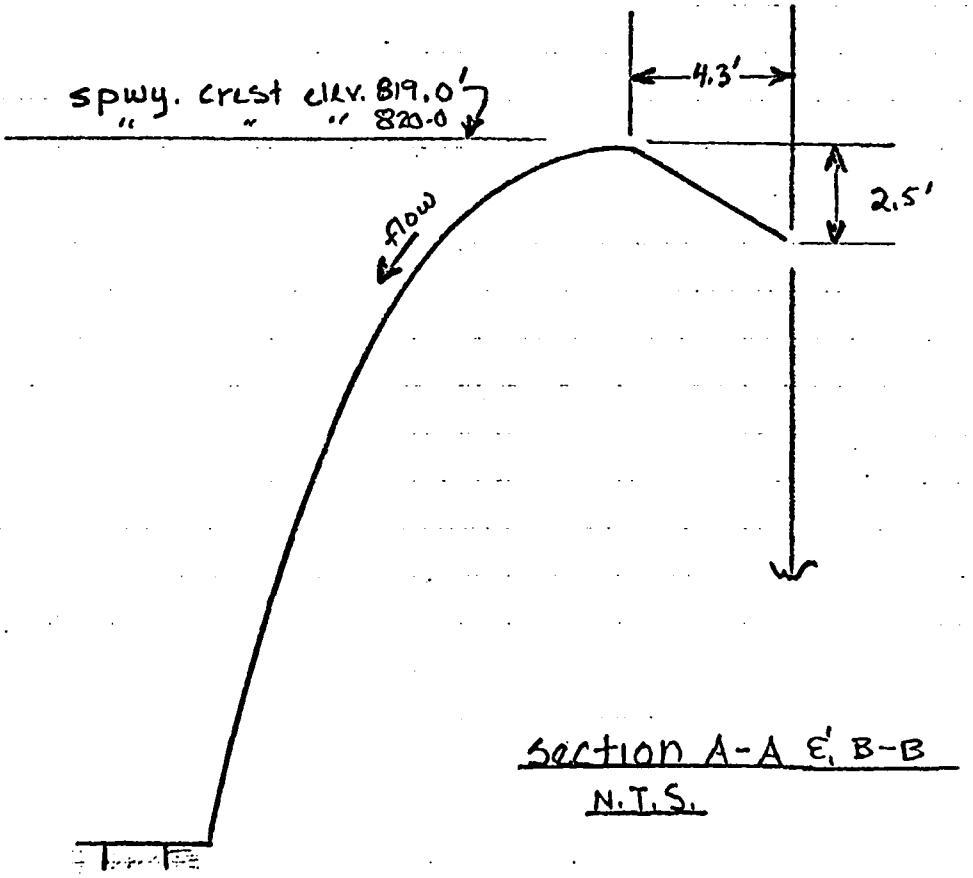
Jan. 1979

SHEPAUG RESERVOIR, Warren and Litchfield, Conn.

SERVICE SPILLWAY



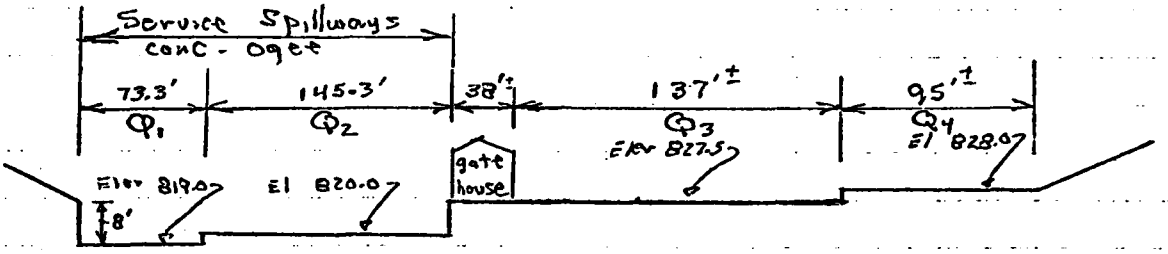
Elevation View
LOOKING UPSTREAM
N.T.S.



Section A-A & B-B
N.T.S.

Feb 1979
By: D.T. Ballou

Work up Rating Curve for Spillway & Dam



Elevation View
Looking Upstream

The spillways are concrete - Ogee shaped, ∴ use a flow coefficient = 3.90.
For flow over the top of the Dam use a flow coefficient of 2.7. Discussions for both selections may be found in Kings Handbook of Hydraulics and other pertinent hydraulic references.

There are four Discharges to be apprised as indicated in the sketch above, Q_1, Q_2, Q_3 & Q_4

$$Q_1 = C L H_1^{3/2} = 3.9 \times 73.3\, H_1^{3/2} = 285.9\, H_1^{3/2}$$

$$Q_2 = C L H_2^{3/2} = 3.9 \times 145.3\, H_2^{3/2} = 566.7\, H_2^{3/2}$$

$$Q_3 = C L H_3^{3/2} = 2.7 \times 137\, H_3^{3/2} = 369.9\, H_3^{3/2}$$

$$Q_4 = C L H^{3/2} = 2.7 \times 95\, H_4^{3/2} = 256.5\, H_4^{3/2}$$

See next page for tabulations.

Shepaug Reservoir

Rating Data Continued

Feb 1979
By: D.T. Ballou

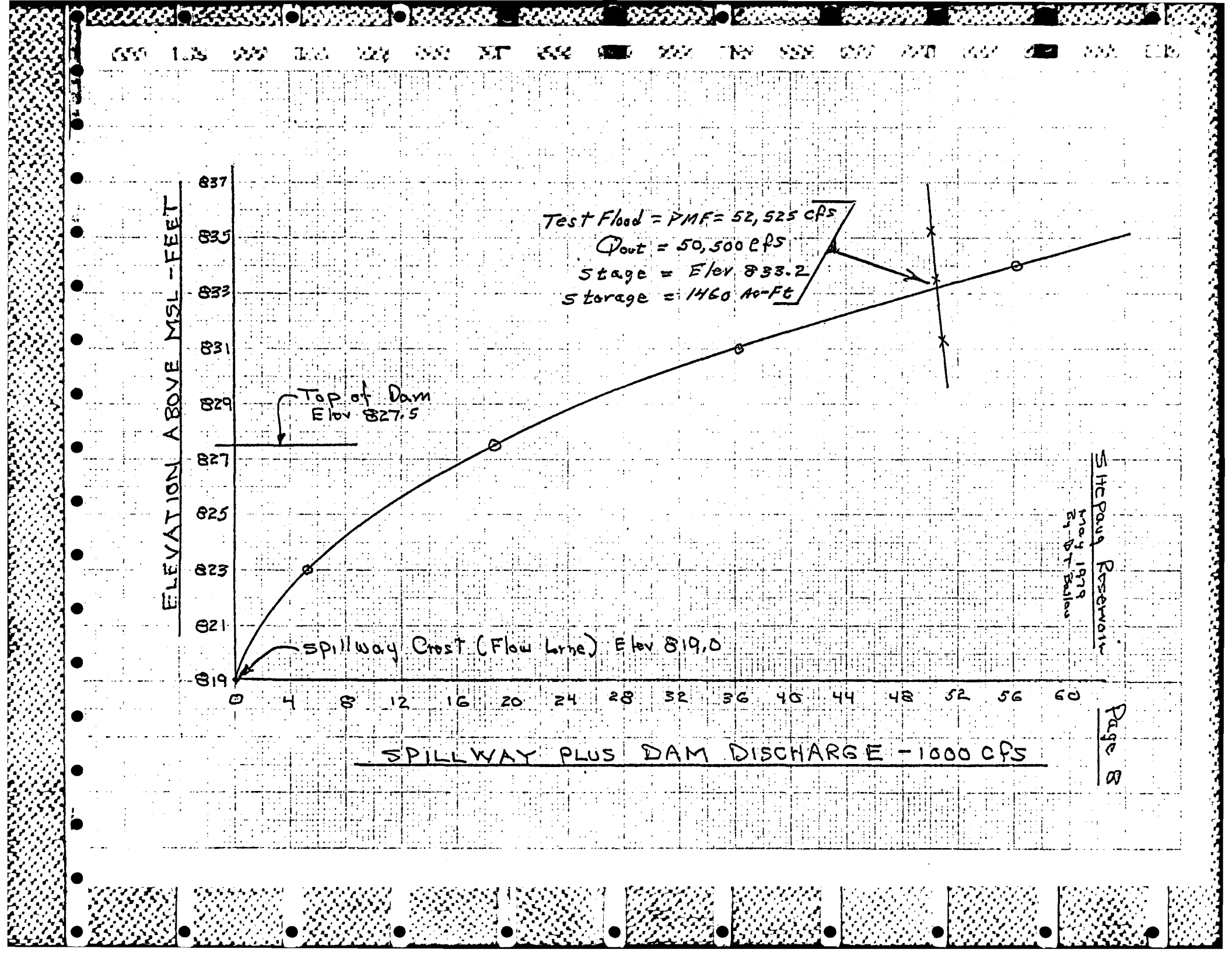
For Discharge Formulas see preceding page

Elev ft	see sketch on pg 6 for location of discharge heads H_1 ft	H_2 ft	H_3 ft	H_4 ft	For location of discharge Q see sketch on page 6 Q_1 cfs	Q_2 cfs	Q_3 cfs	Q_4 cfs	ΣQ cfs
819.0	—	-	—	—	—	—	—	—	—
820.0	1	—	—	-	286	—	-	-	286
821.0	2	1	—	—	809	567	—	—	1,376
822.0	3	2	-	—	1,487	1,604	—	—	3,091
823.0	4	3	—	—	2,287	2,947	-	-	5,234
824.0	5	4	—	—	3,196	4,534	—	—	7,730
825.0	6	5	—	—	4,203	6,336	-	—	10,539
826.0	7	6	—	—	5,295	8,330	—	-	13,625
827.0	8	7	—	—	6,470	10,495	—	—	16,965
827.5	8½	7½	—	—	7,085	11,640	—	—	18,725
828.0	9	8	0.5	—	7,719	12,824	131	—	20,674
828.5	9½	8½	1.0	0.5	8,371	14,044	370	91	22,876
829.0	10	9	1.5	1.0	9,041	15,301	680	257	25,279
830.0	11	10	2.5	2.0	10,430	17,921	1,462	726	30,539
831.0	12	11	3.5	3.0	11,885	20,675	2,422	1,333	36,315
832.0	13	12	4.5	4.0	13,401	23,557	3,531	2,052	42,541
834.0	15	14	6.5	6.0	16,609	29,686	6,130	3,770	56,195

see plot of data on next page

The following rating data is utilized to determine impact on dam surcharge from breaching Q = 245,586 cfs that results from breaching "Upper Shepaug" Dam, See comments on pages 30 & 31. These values are approximate ±, do not include total flow area.!!!

859	40	39	31.5	31.0	72,328	138,022	65,396	44,272	320,018
853	34	33	25.5	25.0	56,680	107,438	47,632	32,063	243,805
849	30	29	21.5	21.0	46,978	88,501	36,876	24,684	197,039


ELEVATION ABOVE MSL - FEET
837
835
833
831
829
827
825
823
821
819
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
Test Flood = PMF = 52,525 cfs
Qout = 50,500 cfs
Stage = Elev 833.2
Storage = 1460 Ac-Ft
Top of Dam
Elev 827.5
Spillway Crest (Flow Line) Elev 819.0
SPILLWAY PLUS DAM DISCHARGE - 1000 cfs
SHC Pond Reservoir
May 1979
24-HR Rainfall
Page 8

Shepaug Reservoir

May 1979
By DT Ballou

Short-cut Routing of PMF, = 52,525 cfs

Select surcharge storage associated with Q_{P_1} = 52,525 cfs.

From stage-discharge curve, page 8, for Q = 52,525 cfs we obtain Elev 833.5

From stage-storage curve, page 4, the storage = 1500 Ac-ft

$$\frac{1500 \text{ Ac-ft}}{24,448 \text{ Acres}} \times \frac{12''}{\text{ft}} = 0.736 \text{ inches of RO.} = \text{Stor}(i)$$

$$Q_{P_i} = Q_{P_1}\left(1 - \frac{\text{Stor}(i)}{19''}\right)$$ where Q_{P_1} = 52,525 cfs = T.F.

Stor(i) = RO (inches); 19" = RO. for T.F.

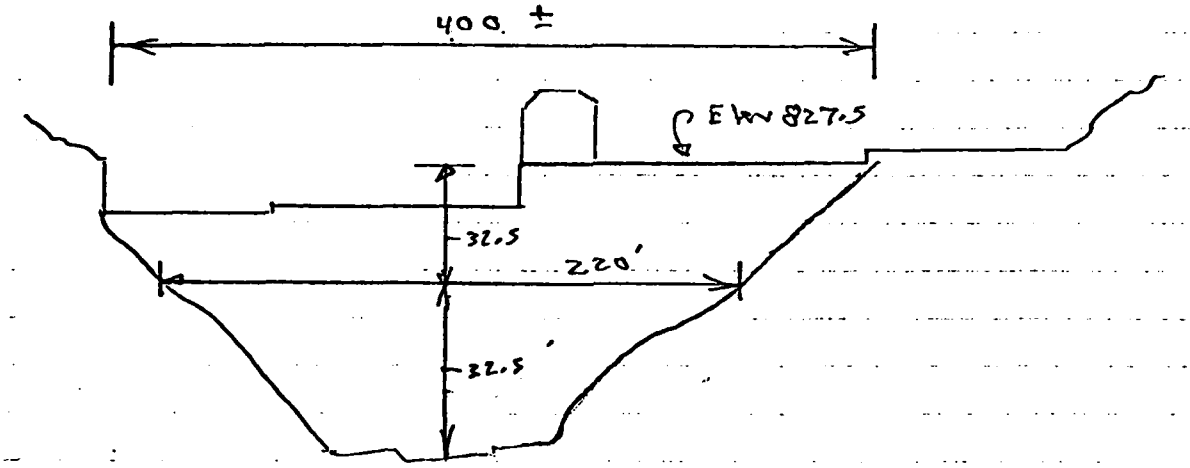
① Stor(i) inches	② $\left(1 - \frac{\text{Stor}(i)}{19}\right)$	③ Stor(i) Ac-Ft ① x Area	④ Q_{P_i} cfs ② x 52,525 cfs	⑤ Elev From page 4 for column ③
0.735	0.961	1500	50,490	833.5
0.85	0.955	1732	50,161	835.2
0.60	0.968	1222	50,866	831.3

A plot of column ④ & ⑤ may be viewed on page 8 with results listed.

Shepaug Reservoir

Feb 1979
By D.T. Ballou

Estimate dam breaching hydrograph



Vertical Section
Looking Upstream

Peak failure Outflow = $Q_{p_1} = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2}$

$W_b = 220' \times 40\% = 88'$

$Y_o = 827.5 - 762.5 = 65'$

and

$Q_{p_1} = \frac{8}{27} \times 88 \times 32.2^{1/2} \times 65^{3/2}$

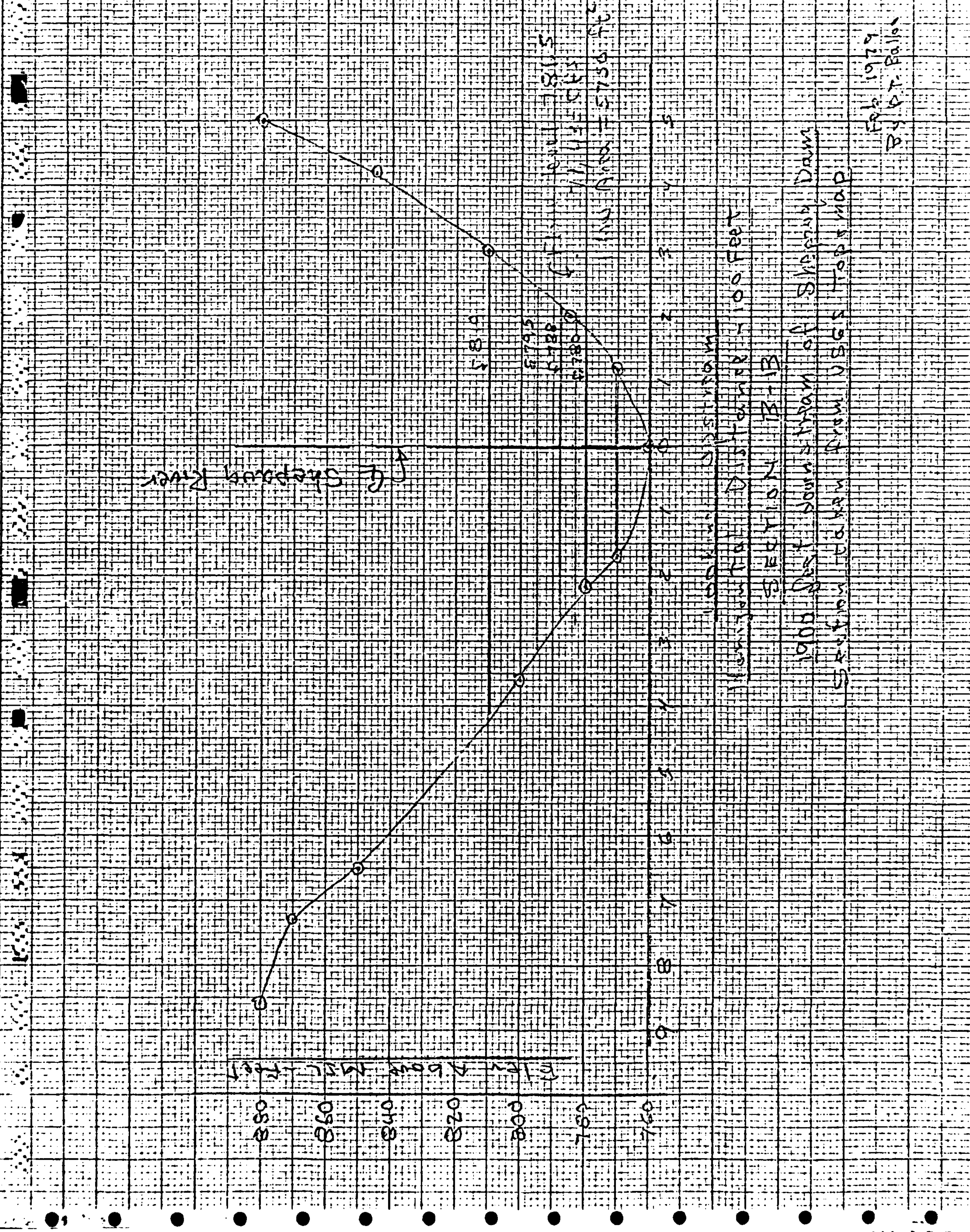
$Q_{p_1} = 77,536$ cfs

Reservoir Storage @ time of breach

1045 Ac-Ft above spillway crest
2037 Ac-Ft below " "
3082 Ac-Ft Total storage

$T_{imp(hours)} = \frac{24.2 \times 3082}{77,536} = 0.96$

Shepaug Reservoir



Shepaug Reservoir

Feb 1979
By DT Ballou

Work up rating curve for Section B-B which is 1900' downstream of the dam.

Use $Q = A \frac{1.49}{n} R^{2/3} S^{1/2}$

where $n = 0.060$

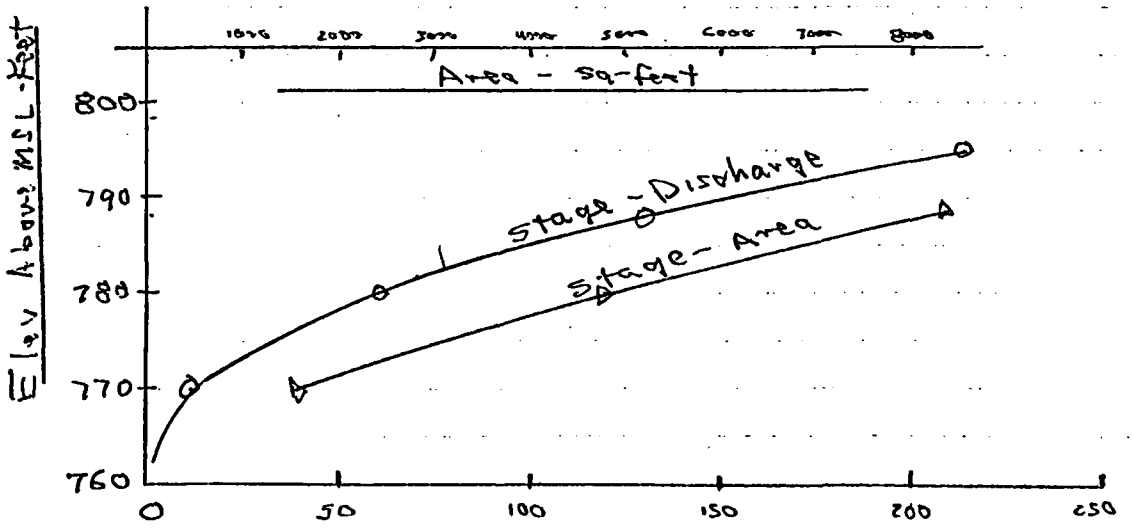
$S = 0.010$ (average of channel slope)

$S^{1/2} = 0.10$, $\frac{1.49}{n} = 24.83$

and $Q = 2.48 A R^{2/3}$

Elev	Area ft^2	WP ft	R ft	$R^{2/3}$	Q cfs
770	1595	310	5.15	2.98	11,776
780	4,800	420	11.43	5.07	60,300
788	8400	536	15.67	6.25	130,219
795	12800	620	19.35	7.21	214,490

Note: Streambed @ elev 760.0

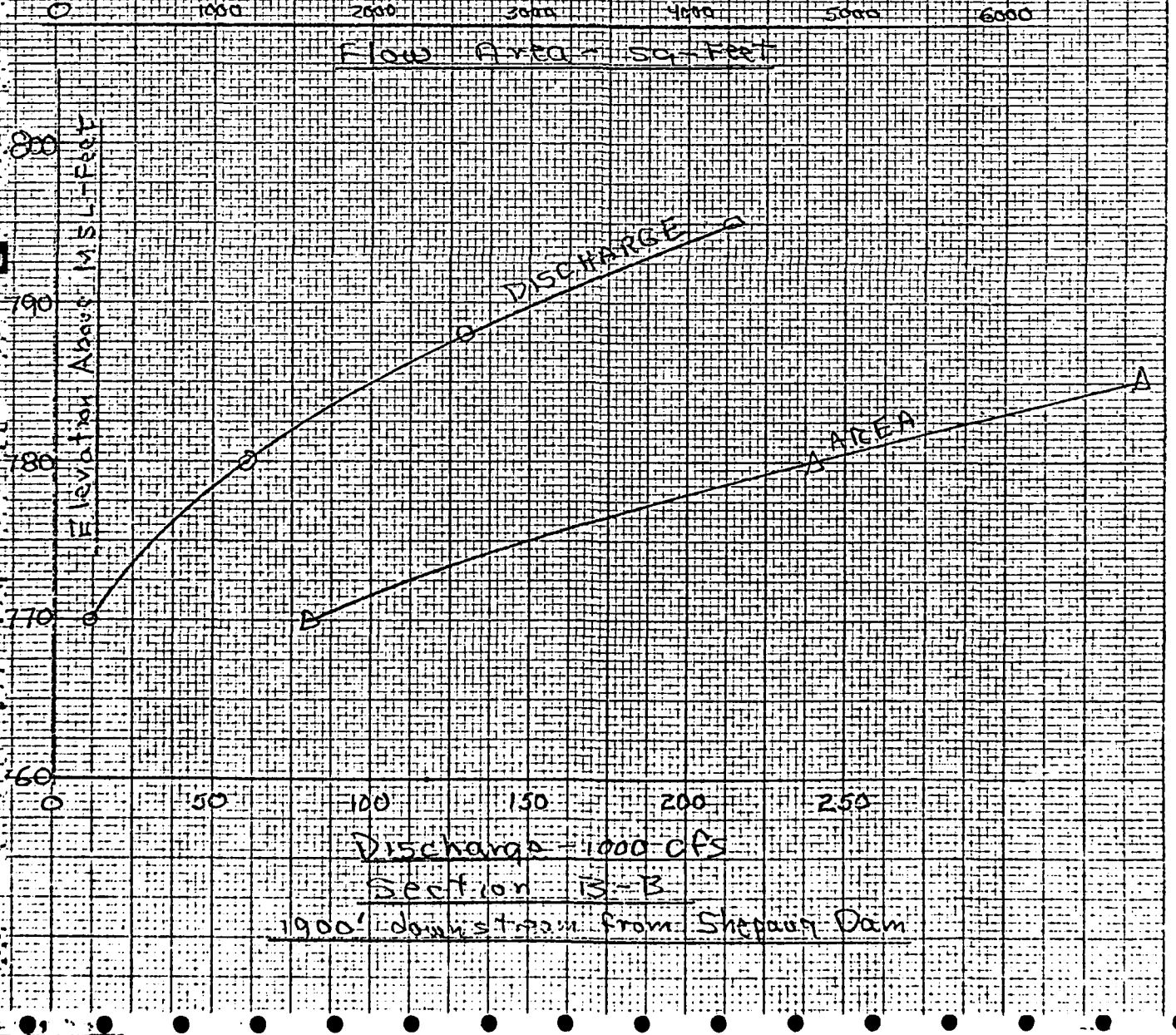


Section B-B

See graph next page

Shepaug Reservoir

Feb 1979
By DT Ballou



Section B-B

1900' downstream from Shepaug Dam

Feb 1979
By: A.T. Ballou

Continue Reach routing by short-cut method from Dam to Section B-B

From page 10
Q_{p_1} = 77,536 cfs
Storage behind Dam @ breach time = 3082 Ac-Ft

From page 13, stage-Discharge curve for Q_{p_1} we obtain elev 782.5
From page 13, stage Area curve we obtain for elev 782.5 an area = 5750 ft²

The reach length = 1900', ∴ volume, V_1 in reach = $1900 \times 5750 / 43{,}560$ = 251 Ac-ft
(graph, pg 13)

Trial $Q_{p_2} = Q_{p_1}\left(1 - \frac{V_1}{S}\right)$

$= 77{,}536\left(1 - \frac{251}{3082}\right) = 71{,}221$ cfs

using Q_{p_2} we obtain elev 781.5
and resulting $V_2 = 1900 \times 5370 / 43560 = 234$ Ac-Ft
(graph, pg 13)

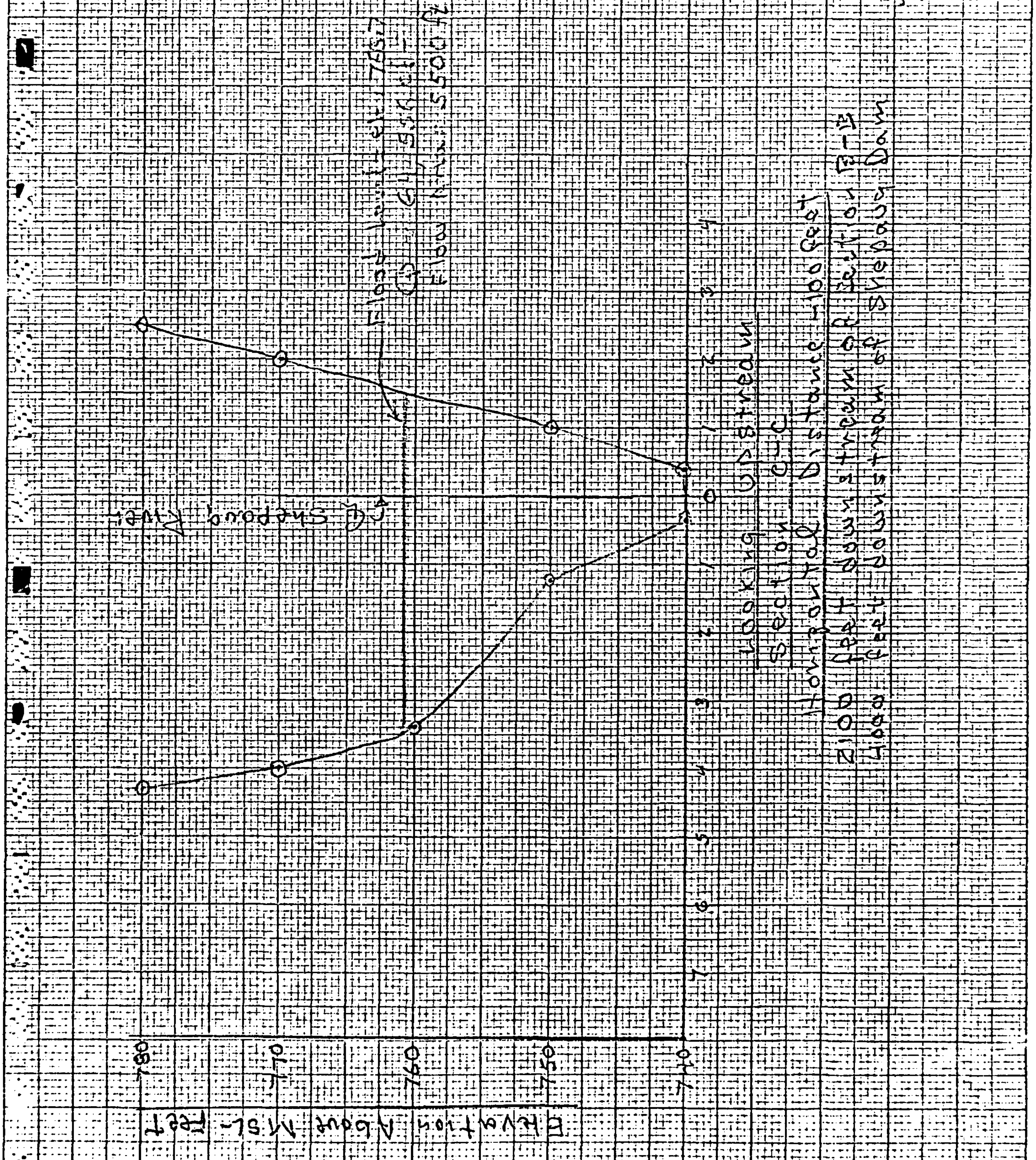
Recomputed $Q_{p_2} = 77{,}536\left(1 - \frac{(V_1+V_2)/2}{3082}\right) = 71{,}435$ cfs
and water stage ≅ 781.5

Select another reach downstream and repeat the process except that Q_{p_1} will now = 71,435 cfs
The storage "S" should reduce to.
3082 − 242 = 2840 Ac-Ft.

Shepaug Reservoir

Feb 1977

By DT Ballou



Feb 1979

By: DT Ballou

Control reach routing from Section B-B to section C-C

Use $Q = A \frac{1.49}{n} R^{2/3} S^{1/2}$

where:

$n = 0.060$

$S \cong 0.01$ ft/ft, $S^{1/2} = 0.1$

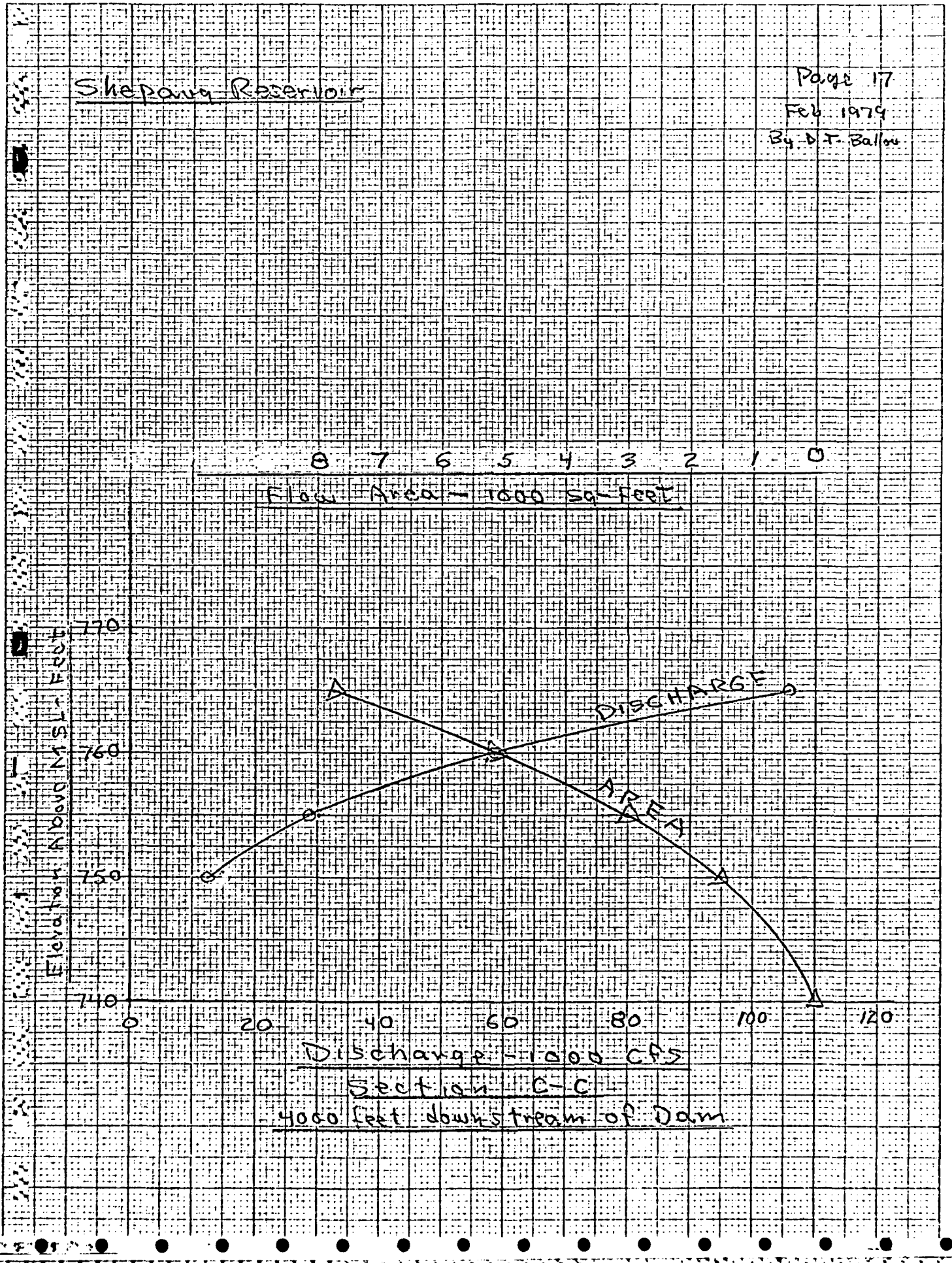
$$Q = 2.48 A R^{2/3}$$

Elev	Area ft^2	WP ft	R ft	$R^{2/3}$	Q cfs
740	—	—	—	—	—
750	1500	245	6.12	3.34	12,435
755	3000	400	7.50	3.83	28,468
760	5150	525	9.81	4.58	58,438
765	7750	600	12.92	5.50	105,790

Shepaug Reservoir

Feb 1979

By D T Ballou



Section C-C

4000 feet downstream of Dam

Shepaug Reservoir

Feb 1979
By: D.T. Ballou

Continue reach routing between Section B-B & C-C

"Q_{P_1}" from page 14 = 71,435 cfs
"S" from page 14 = 2840 Ac-Ft

From page 17 for Q_{P_1} we obtain Elev 761.5
From " " for Elev 761.5 we obtain 5850 ft²

The reach length = 2100', ∴ Reach Volume V_1
= 2100 × 5850 / 43560 = 282 Ac-Ft.

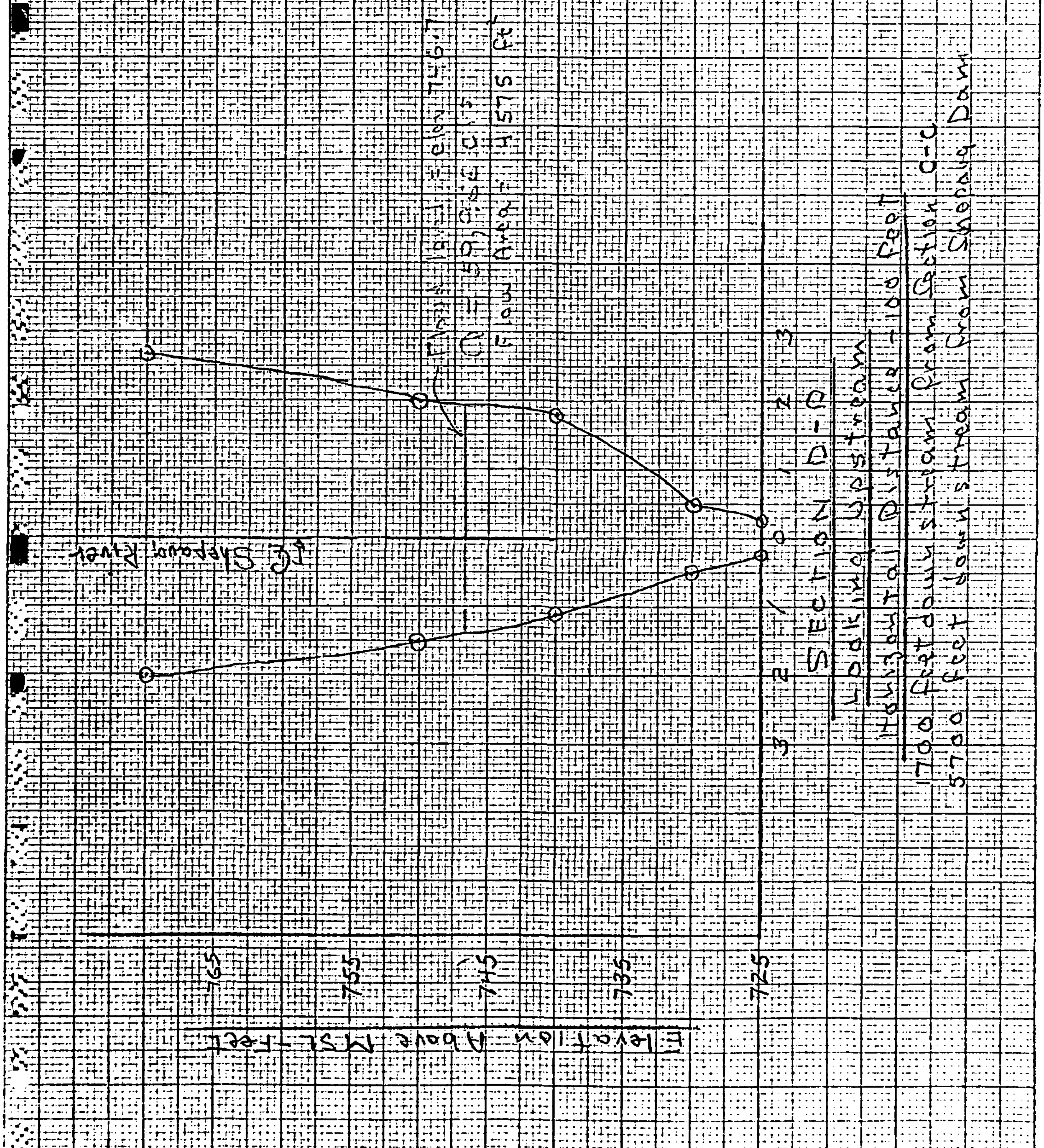
Trial $Q_{P_2} = 71,435\left(1 - \frac{282}{2840}\right) = 64,342$ cfs

Using Q_{P_2} for entry on page 17 we get elev 760.7, and resulting area = 5500 ft²; and
V_2 = 2100 × 5500 / 43,560 = 265 Ac-Ft

Recomputed $Q_{P_2} = 71,435\left(1 - \frac{(V_1+V_2)/2}{2840}\right) = 64,556$ cfs
and flood stage @ C-C = Elev 760.7

Select another reach downstream
Q_{P_1} will now be 64,556 cfs
Storage = 2840 − 273 = 2567 Ac-Ft

Feb 1979
By D.T. Ballou



Shepaug Reservoir

Feb 1979
By D.T. Ballou

Continue Routing from Section C-C → D-D

Use $Q = A \frac{1.49}{n} R^{2/3} S^{1/2}$

$n = 0.06$

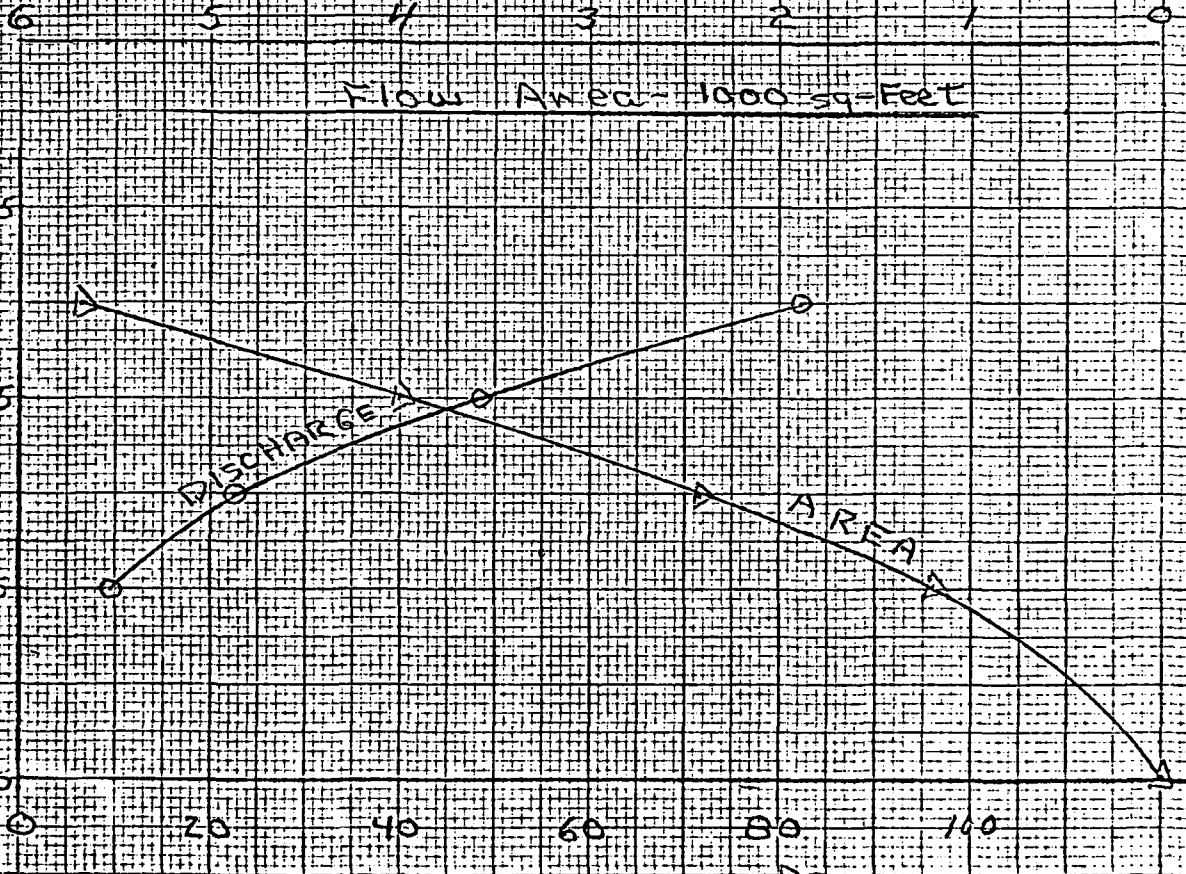
$S = 0.01$

$Q = 2.48 A R^{2/3}$

Elev	Area ft^2	WP ft	R ft	$R^{2/3}$	Q cfs
725	—	—	—	—	—
735	1200	225	5.33	3.05	9,074
740	2425	325	7.46	3.81	22,933
745	4000	370	10.81	4.88	48,424
750	5675	400	14.19	5.85	82,335

Shepaug Reservoir

Page 21
Feb 1979
By: D.T. Ballou



SECTION D-D

5700 feet downstream from Shepaug Dam

Shepaug Reservoir

Feb 1979
By: D.T. Ballou

Continue routing from Section CC-DD

Q_{p_1} from page 18 = 64,556 cfs
S " " " = 2,567 Ac-Ft

From page 21 for Q_{p_1} we obtain elev 747.5
" " " " Elev 747.5 we get 4800 ft²

The reach length = 1700 feet, ∴ reach volume V_1
= 1700 × 4800 / 43560 = 187 Ac-Ft

Trial $Q_{p_2} = 64,556\left(1 - \frac{187}{2567}\right) = 59,853$ cfs

Using Q_{p_2} for entry on page 21 we obtain elev 746.6 E', resulting area of 4550 ft².
V_2 = 1700 × 4550 / 43560 = 178 Ac-Ft

Recomputed $Q_{p_2} = 64556\left(1 - \frac{(V_1+V_2)/2}{2567}\right) = 59,966$ cfs
and the flood stage @ D-D = elev 746.7

New Q_{p_1} = 59,966 cfs
storage = 2567 − 183 = 2384 Ac-ft

Final Summary of Downstream Flooding

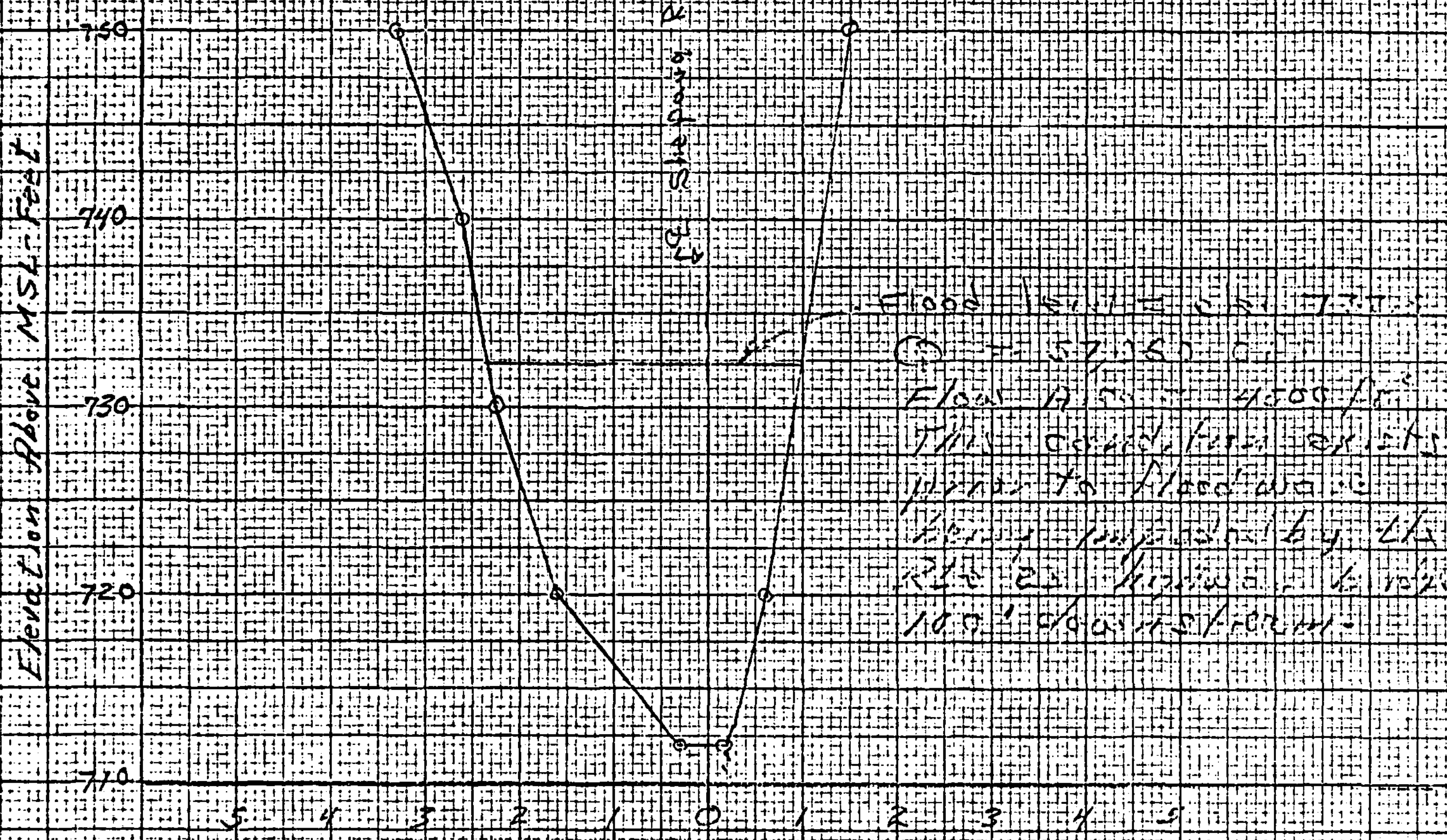
Note: Additional Section taken downstream.

Point	Water Surface Elevation	Discharge	Comment
Dam	828.9	24,850	Before Breaching
Dam	807	77,536	sta 0+00
B-B	781.5	71,435	sta 19+00
C-C	760.7	64,555	sta 40+00
D-D	746.7	59,966	sta 57+00
E-E	732.3	57,060	sta 68+00

Note: Computed from Dam → D-D, leaving out B-B & C-C E', got 61,082 cfs E' elev 746.8. (Serves as check)

Shepard Reservoir

Page 23
April 1979
By: D.T. Ballou



SECTION E-E

LOOKING UPSTREAM

Horizontal Distance – 100 ft

1100 feet downstream from Section D-D

6800 feet downstream from Shepaug Dam

Shepaug Reservoir

SECTION E-E

April 1977
By DT Ballou

Continue Routing from D-D → E-E

Use $Q = A \frac{1.49}{n} R^{2/3} S^{1/2}$

where $n = 0.060$

$S = 0.01$

$\therefore Q = 2.48 AR^{2/3}$

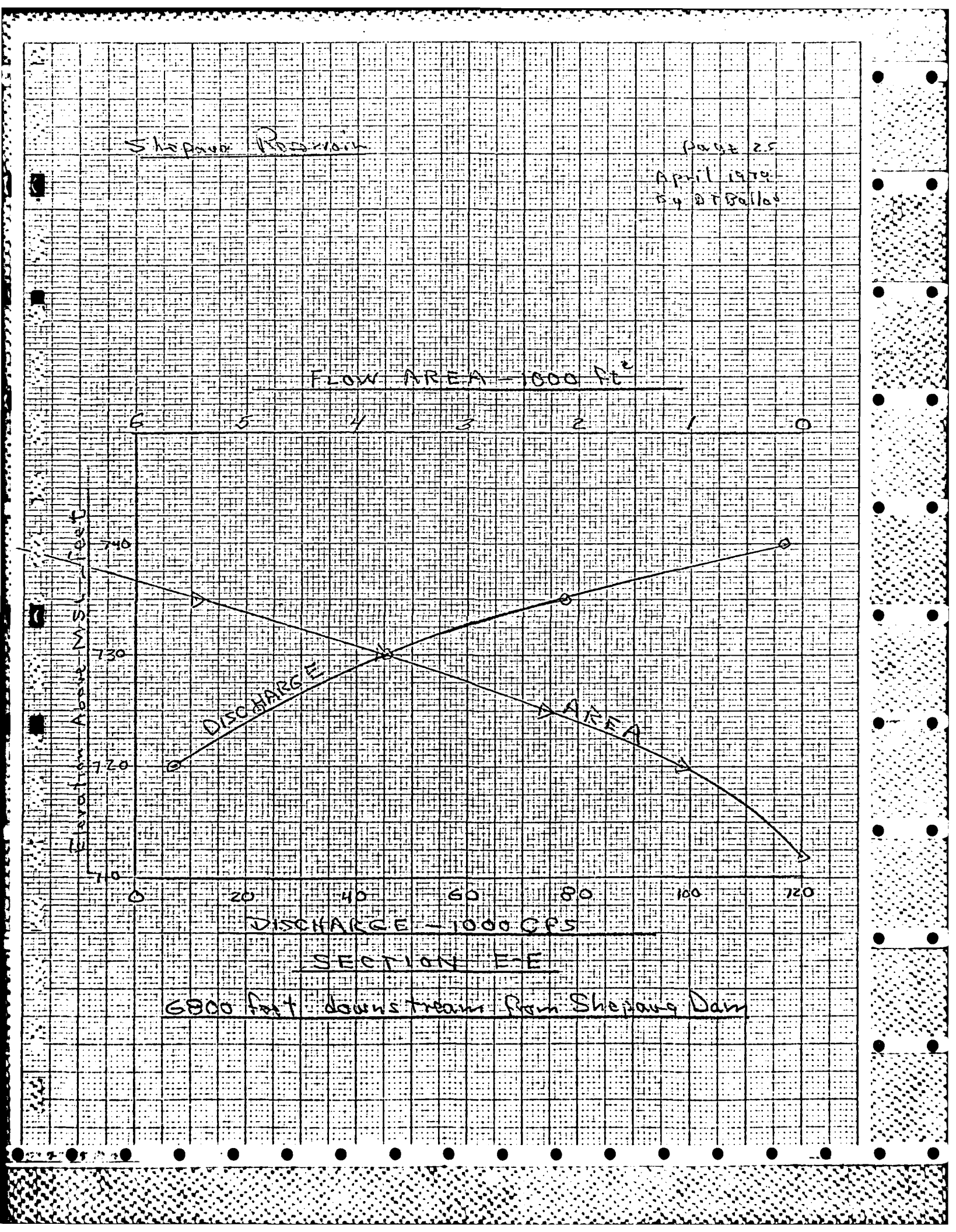
Elev	Area ft^2	W.P ft	R ft	$R^{2/3}$	Q cfs
712	—	—	—	—	—
720	1080	236	4.58	2.75	7,375
725	2305	296	7.79	3.92	22,428
730	3780	354	10.68	4.84	45,385
735	5455	396	13.78	5.74	77,604
740	7280	441	16.51	6.47	116,833
745	9330	496			
750	11605				

Shepaug Project

Page 25

April 1979

By D T Ballou



SECTION E-E

6900 feet downstream from Shepaug Dam

April 1979
By DT Ballou

Continue Routing from D-D → E-E

Q_{p_1} from page 22 = 59,966 cfs
S " " " = 2,384 Ac-ft

From page 25 for Q_{p_1} we obtain elev. 732.7
" " " " elev 732.7 we obtain 4650 ft²

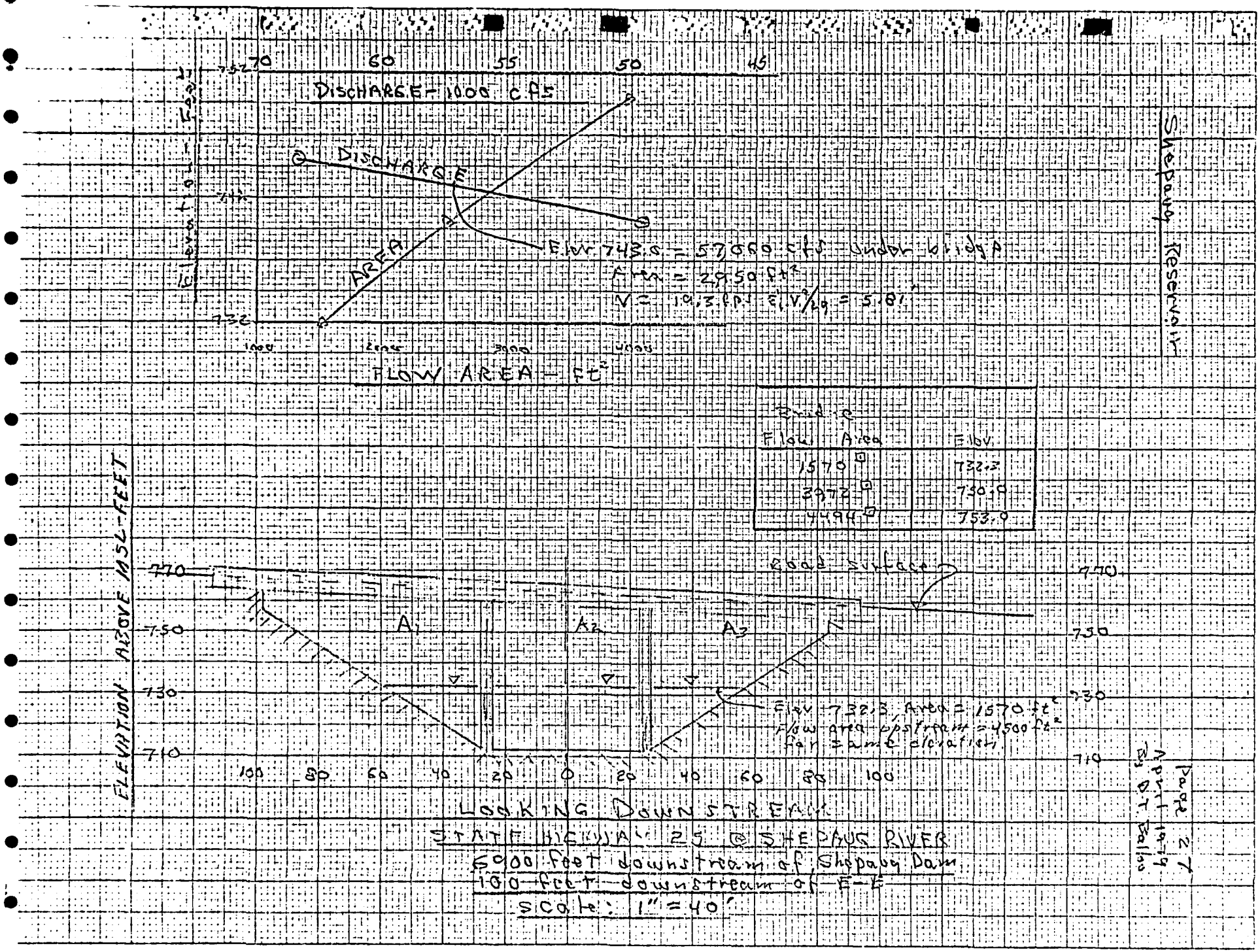
The reach length = 1100 feet, ∴ reach volume V_1
= 1100 × 4650/43560 = 117 Ac-Ft

Trial $Q_{p_2} = 59{,}966\left(1 - \frac{117}{2384}\right) = 57{,}012$ cfs
using Q_{p_2} for entry on page 25 we obtain
elev 732.3 ∴ resulting area of 4500 ft²
and, V_2 = 1100 × 4500/43560 = 114 Ac-ft

Recomputed $Q_{p_2} = 59{,}966\left(1 - \frac{V_1 + V_2}{2384}\right) = 57{,}060$ cfs
and the flood stage @ E-E = elev 732.3
Flow area ≐ 4500 ft²

For another downstream reach the
new Q_{p_1} = 57,060 cfs
storage = 2384 − 115 = 2269 Ac-Ft

Note: There is a bridge over the river 100 feet downstream of section E-E See next sheet for scale section of bridge. See page following the bridge for further comments.


Shepaug Reservoir
DISCHARGE - 1000 CFS
Q
DISCHARGE
AREA
E.W 743.5 = 57060 cfs under bridge
A = 2950 ft²
V = 19.3 fps E.V²/2g = 5.81'
FLOW AREA - ft²
Area
Flow
1570
3972
4494
Elev
732.3
750.9
753.0
Road surface
A1
A2
A3
Elev 732.3, Area = 1570 ft²
750 area upstream = 4500 ft²
Elev + same elevation
ELEVATION ABOVE MSL-FEET
LOOKING DOWNSTREAM
UNITED BIOSYSTEMS @ SHEPAUG RIVER
5000 feet downstream of Shepaug Dam
100 feet downstream of F-E
Scale: 1" = 40'
Page 27
April 1989
By D.T. Ballou

April 1979
By BT Ballou

Find Energy balance thru bridge utilizing approximate solution.

Given:

$Q = 57,060$ cfs

Area Curves for Section E-E' bridge (see sheets 25 & 27)

Assume stream bed @ E-E' bridge are same

Compute

Compute annual flows, $\frac{v^2}{2g}$ + depth for section E-E' the bridge & compare.

	SECTION E-E			BRIDGE		
ELEV	Area	V	$v^2/2g$	Area	V	$v^2/2g$
732.3	4500	12.68	2.5	1570	36.3	20.5
740	7280	7.84	1.0	2525	22.6	7.9
745	9330	6.12	0.6	3240	17.6	4.8
750	11605	4.92	0.4	3972	14.4	3.2

Evaluate bridge using Mannings
$n = 0.035$, $S = 0.010$ $Q = 4.26\ A R^{2/3}$
see plot on page 27.

Elev	A_1	WP_1	Q_1 cfs	A_2	WP_2	Q_2	A_3	WP_3	Q_3	ΣQ
732.3	315	57	4,190	950	87	19,887	305	50	4,333	28,410
740.0	602	78	10,002	1310	103	30,355	574	78	9,239	49,596
745.0	825	93	15,038	1544	113	37,527	792	91	14,255	66,820

April 1979
By DT Ballou

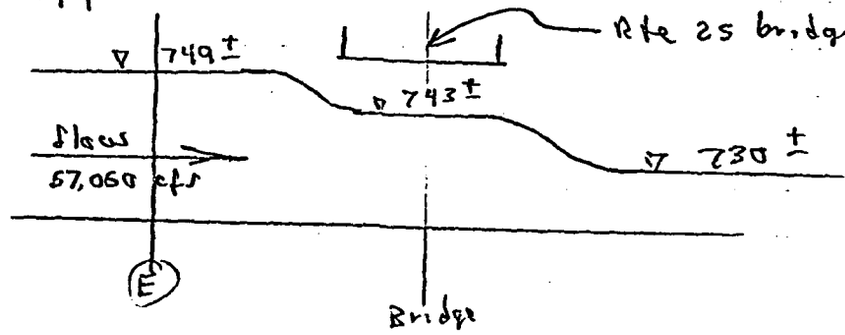
Summary & Comments

Pages 23 → 26 contain data pertinent to evaluation of Section E-E

Page 27 contains bridge data

Page 28 contains: evaluations of Section E-E and the bridge

Section E-E carries the 57,060 cfs @ elev 732.3, however, evaluation of the bridge indicates that 57,060 cfs passes thru @ elev 743.0. The $v^2/2g$ associated with this flow under the bridge is 5.8' (see graph page 27). Consequently the upstream water surface @ E-E would @ least be @ 743+5.8 = 748.8 when evaluating minimum energy principles. Hence, it looks to be, as an approximation:



It appears that the bridge would cause a backwater @ about elev 750 for a distance of approximately 2000' upstream.

Shepaug Reservoir

April 1979
By D T Ballou

Comments & Recommendations

1. It would appear that the Hazard classification of High initially selected still remains in effect.

2. The water surface upstream of the bridge = elev 249 which is a depth of about 37 feet.

3. A formal analysis of the floodwaters between Shepaug Dam and the highway bridge may be desirable.

4. There appears to be approximately twelve houses in the path of the flood wave.

5. Shepaug being an important link in the water supply for the Waterbury area would be further cause for a hazard rating of High

6. No conduits were incorporated in the Test Flood routing

7. Note that with the reservoir level in Shepaug @ the spillway crest and upper Shepaug breached, that the storage (14,700 Ac-ft) behind upper Shepaug would cause a surcharge @ Shepaug of 77' (Seventy-seven) feet above the spillway crest @ Shepaug. The surcharge would be @ elev 896.0. Also note that this is purely on a volume basis.

continued

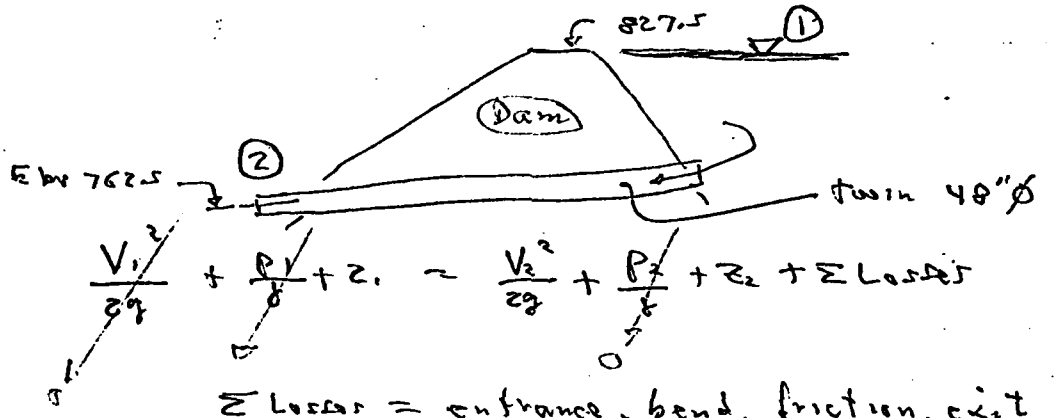
A more realistic approximation would be to utilize the breaching discharge computed @ Upper Shepaug of 245,600 cfs & find the point on the rating curve that will pass 245,600 cfs. Computations may be found on page 7 near the bottom of the page that indicate a 34 foot head will pass approx. 244000 cfs.

The 34' head is considerably less than the 77' head that was computed purely on a volumetric basis.

Also note that in computing the 34' head (see page 7) the rating equations on page 6 were utilized. These equations do not allow for the additional flow area resulting from such an increase of head over the dam. Thus for the 34' in itself is conservative. Any further refinement would not be warranted in terms of present project scope.

Very preliminary calculation of amount of discharge that the 2-48" C.F. Pipes would be capable of with:

1. No flow restrictions (losses)
2. 65' of head



$$\frac{V_1^2}{2g} + \frac{P_1}{\gamma} + z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\gamma} + z_2 + \Sigma \text{Losses}$$

Σ Losses = entrance, bend, friction, exit & possibly other control devices within the H_2O conveyance system

$$z_1 = \frac{V_2^2}{2g} + z_2 \quad \text{let } z_2 = 0$$

$$V_2 = \sqrt{2gz_1}$$

$$Q = AV = A\sqrt{2gz_1} =$$

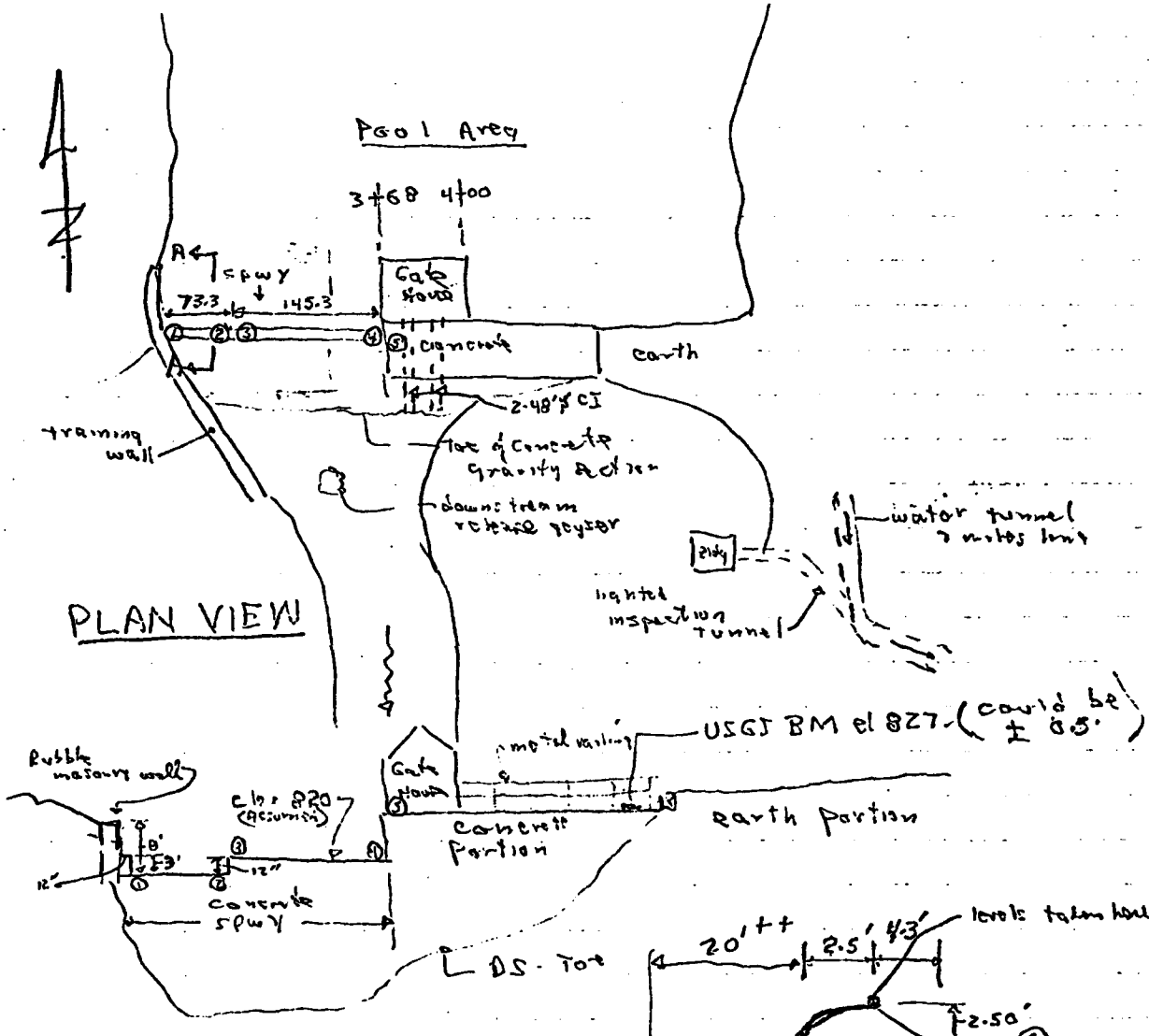
$$= 25.1 \times 8.02 \times 65^{1/2}$$

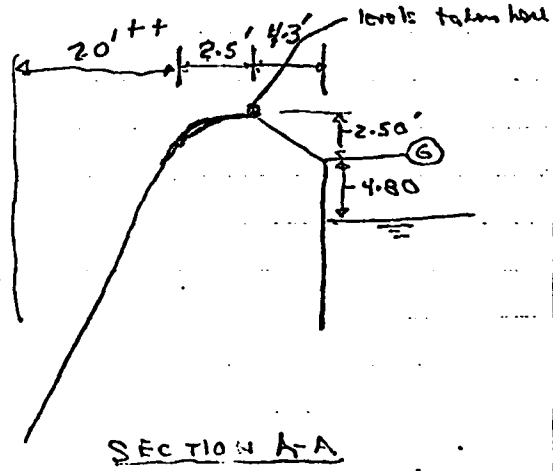
$$= 1624 \text{ cfs}$$

The discharge would obviously be less when performing a proper hydraulic analysis

SHEPAUG RESERVOR

12/6/78
By Don Bailey
11:15 - 12:45
@ site



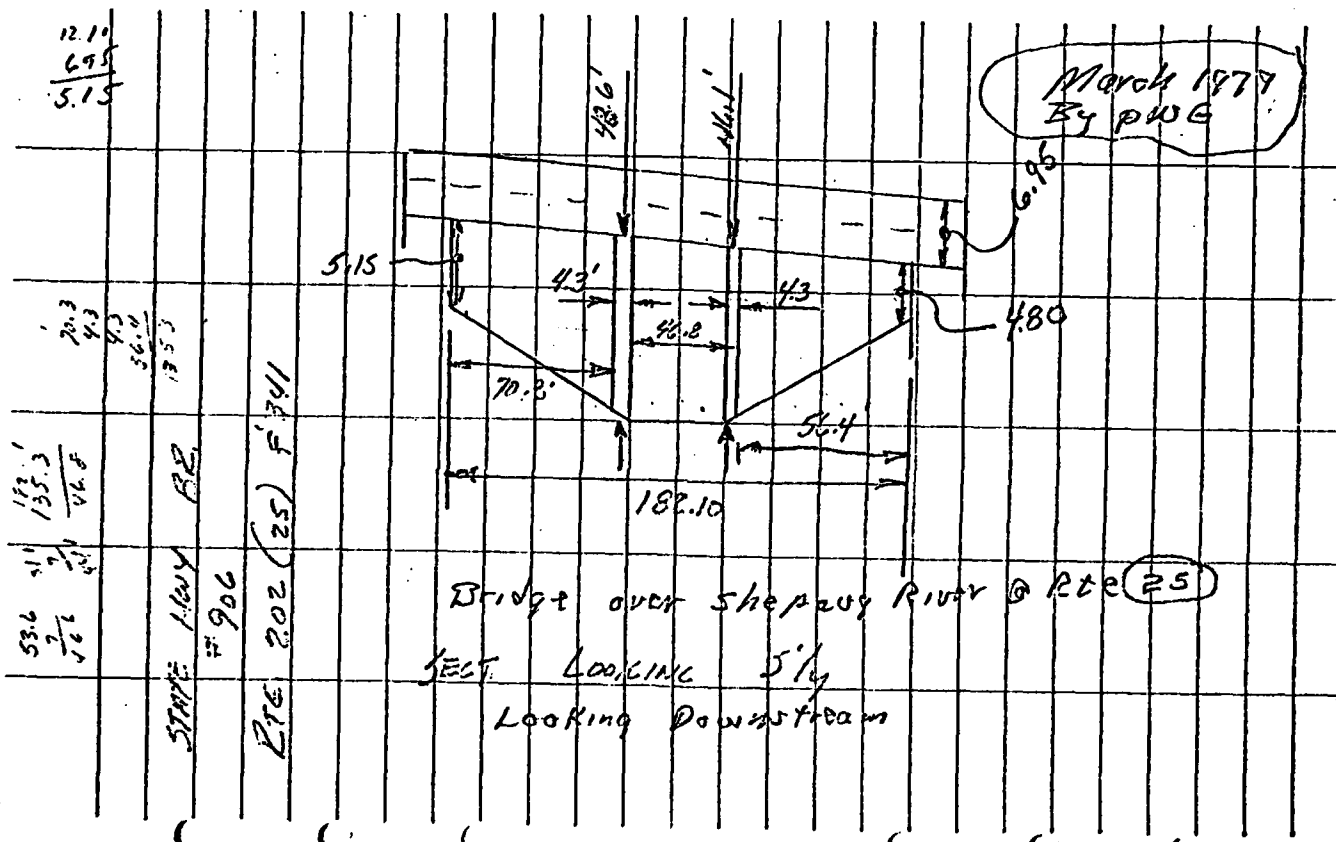


℄ profile along Dam
Looking upstream

HI = 831.02

Item	BS	FS	Elev
① spwy	12.02		819
② spwy		12.02	819
③ spwy		11.01	820
④ spwy		11.03	820
⑤ Top of Dam (conc)		3.48	827.5
⑥ Rear edge of spwy on West spwy See Section A-A		14.52	816.5

SECTION A-A
spillway - west section
East section same except for elev.


March 1979
By pwG
5.15
4.3'
4.3
46.8
70.2'
56.4
182.10
6.96
4.80
STATE HWY #906
Rte 202 (25) F'311
Bridge over Shepaug River @ Rte (25)
SECT Looking S'ly
Looking Downstream

APPENDIX E

INFORMATION AS CONTAINED IN THE INVENTORY OF DAMS